The welfare impact of the removal of input subsidies for crop production in Lesotho

by
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Thesis presented in a partial fulfilment of the requirements for the degree of Master of Science (Agricultural Economics) in the Faculty of AgriSciences at Stellenbosch University

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March 2016

Declaration

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Acknowledgements

First and foremost, I would like to thank God the Almighty. He is everything good that's ever happened to me. For this work I lift up His name high, for He is worthy of the praise. I believed it when He said "…*at the time I have decided my words will come true. It may take a long time but keep on waiting, it will happen*." Habakkuk 2:3.

My deepest gratitude goes to Dr. Cecilia Punt for supervising this work with great attitude. Thank you for your constructive criticism and support. I am immensely overwhelmed by the kindness and patience you showed towards me. This work would not have been possible without you. I also thank Prof Vink and all the Department of Agricultural Economics at Stellenbosch University for allowing me to be part of their family for these past three years.

To my family, thank you for your unconditional love and support. Your prayers and financial support have been noticed. A shout goes to my friends for their love and their constant encouragement. Special thanks go to my son Boiketlo for being the motive behind the completion of my master's degree when I had lost all hope.

Further acknowledgements go to the following people and institutions:

- The National Manpower Development Secretariat (NMDS) and the Postgraduate and International Office (PGIO) at Stellenbosch University for funding my studies.
- Prof Karl Rich for allowing me to use his model and granting me the GAMS codes of the model.
- Mr Maduna Mafeka and Motlatsi Kumi from the Bureau of Statistics (BOS) Lesotho for providing me with Continuous Multi-purpose survey data (CMS).
- Mr Thabo Sofonea from the department of agriculture BOS for providing me with agricultural production survey data.
- Mrs Boitumelo Mamakhabane Mote and Katleho Mats'abisa from the Department of Crops at Ministry of Agriculture and Food Security (MOAFS) for their provision of fertiliser subsidy data.
- Mr Maoala Khesa from the department of planning at MOAFS for provision of 'subsidy document paper' and the information on costs of the program.
- Jambo Newettie for assisting me with STATA to classify data according to the needs of the model.

Abstract

The dwindling agricultural production and extreme poverty in Lesotho and most of sub-Saharan Africa has let governments to resort to fertiliser subsidies as a strategy to combat poverty and attain household food security. However, the efficiency analysis of input subsidies in these countries showed that the costs of the programs outweigh the benefits. For this reason, fertiliser subsidies are discouraged.

In Lesotho fertiliser subsidy seem to not be a good tool to ensure food security as a country is prone to natural disasters like droughts and floods. Agricultural production remained low despite the presence of fertiliser subsidy program. This had let one to question the extent to which fertiliser subsidy improves agricultural production. Household food security is achieved when there is availability of food in households. Also household food availability enhances welfare. The objective of this study was therefore to determine the impact of removing fertiliser subsidy on production, prices, income and consumption as well as fertiliser demand.

The objective was achieved through the use of the multi-market model developed by Lundberg and Rich (2002) for Africa. Products used in the model are differentiated into internationally tradable products (maize, wheat, cash crops, non-foods and fertiliser) and internationally non-tradable products (sorghum, other foods and livestock). Households were classified into urban poor and urban rich, rural poor and rural rich.

The results indicate that the withdrawal of fertiliser subsidy reduces crop production while production of livestock increases. Non-food production is not affected. Subsequently, income in urban households increases and income of rural households decreases. This is because livestock (broiler) production is an urban activity while crop production is mostly rural based. Prices of internationally tradable products are not affected while prices for products not traded internationally increased. As a result, consumption of tradable products increased and consumption of non-tradable products decreased. Fertiliser consumption declines by more than half.

Conclusion based on these results are that the fertiliser subsidy contributes to about 15% of maize production, 8% of wheat and 7% of sorghum and cash crops (beans) production as well as a modest 3% contribution to production of other food (leafy green vegetables). Though the opportunity cost of the fertiliser subsidy is not measured in this study, the M10.11m which is the cost of the fertiliser subsidy program could be used to fund programs that generate non-agricultural income for poor households. This will enable them to afford imported food hence, their welfare will be improved.

Opsomming

Die dalende landbou produksie en uiterste armoede in Lesotho en die meeste van sub-Sahara Afrika, het daartoe gelei dat regerings hulle wend na kunsmissubsidies as ‘n strategie om armoede teen te werk en om voedselsekuriteit op huishoudingvlak te bewerk. Desnieteenstaande het die doeltreffendheidsanalise van inset subsidies in hierdie lande gewys dat die koste van die progamme meer is as die voordele. Vir hierdie rede word kunsmissubsidies ontmoedig.

In Lesotho blyk dit dat kunsmissubsidies nie ‘n goeie instrument is om voedselsekuriteit te verseker nie aangesien die land geneig is tot natuurlike rampe soos droogtes en vloede. Landbouproduksie het laag gebly tenspyte van die kunsmissubsidie program. Dit het daartoe gelei dat die mate waartoe die kunsmissubsidie program landbouproduksie verbeter, bevraagteken word. Voedselsekuriteit op huishoudingvlak word bereik wanneer voedsel vir huishoudings beskikbaar is. Voedsel beskikbaarheid vir huishoudings verbeter ook welvaart. Die doelwit van die studie was dus om te bepaal wat die impak is van die verwydering van die kunsmissubsidie op produksie, pryse, inkomste en verbruik, sowel as die vraag na kunsmis.

Die doelwit is behaal deur die gebruik van die multi-mark model ontwikkel deur Lundberg en Rich (2002) for Afrika. Produkte gebruik in die model word onderskei as internasionaal verhandelbare produkte (mielies, koring, kontantgewasse, nie-voedsel en kunsmis) asook internasionaal nie-verhandelbare produkte (sorghum, ander voedsel en lewendehawe). Huishoudings was geklassifiseer as stedelik arm en stedelik ryk, landelike arm en landelik ryk.

Die resultate dui daarop dat die onttrekking van die kunsmissubsidie gewasproduksie verminder, terwyl produksie van lewendehawe toeneem. Nie-voedsel produksie word nie geaffekteer nie. Voorts, inkomste van stedelike huishoudings neem toe en inkomste van landelike huishoudings neem af. Dit is omdat lewendehawe (braaikuiken) produksie meestal in stedelike gebiede plaasvind terwyl gewasproduksie meestal in landelike gebiede plaasvind. Pryse van internasionale verhandelbare produkte word nie geaffekteer nie, terwyl pryse van produkte nie internasionaal verhandelbaar is nie, toeneem. Gevolglik, neem verbruik van verhandelbare produkte toe en neem verbruik van nie-verhandelbare produkte af. Kunsmisverbruik neem met meer as die helfte af.

Gevolgtrekkings gebaseer op die resultate is dat die kunsmissubsidie bydra tot omtrent 15% van mielieproduksie, 8% van koring en 7% van sorghum en kontantgewas (bone) produksie, sowel as ‘n beskeie 3% bydrae tot die produksie van ander voedsel (groen blaargroentes). Alhoewel die geleentheidskoste van die kunsmissubsidie nie in hierdie studie gemeet word nie, kan die M10.11m wat die koste van die kunsmissubsidie program is, gebruik word om programme te befonds wat nie-

landbou inkomste vir arm huishoudings genereer. Dit sal hulle instaat stel om ingevoerde kos te bekostig, dus sal dit welvaart verbeter.

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List of Abbreviations

BOS	Bureau of Statistics
CBL	Central Bank of Lesotho
CGE	Computable General Equilibrium
CMS	Continuous Multi-purpose Survey
DAFF	Department of Agriculture, Forestry and Fisheries
DMA	Disaster Management Authority
FAO	Food and Agricultural Organisation
FSSP	Food Self-Sufficiency Project
GAMS	General Algebraic Modelling System
GIEWS	Global Information and Early Warning System
GoL	Government of Lesotho
IFPRI	International Food Price Research Institute
IITA	International Institute of Tropical Agriculture
ITC	International Trade Centre
M	Maloti
MOAFS	Ministry of Agriculture and Food Security
MTICM	Ministry of Trade and Industry, Cooperatives and Marketing
MT	Metric-tonnes
NLP	Non-Linear Programming
OLS	Ordinary Least Squares
PAM	Policy Analysis Matrix

SADC	Southern African Development Community
SAM	Social Accounting Matrix
REWU	Regional Early Warning Unit
WB	World Bank
WFP	World Food Program

1. Introduction

1.1 Background

Improving farm activities has proved to be an essential ingredient in stimulating poverty alleviation for many poor rural areas (Dorward, Kydd, Morrison, & Urey, 2004). One way of improving the agricultural sector is the implementation of policies that support farmers (Anderson, 2010). In developing countries, farm support is mostly based on subsidization of farm inputs (Xu, Burke, Jayne, & Govereh, 2009). This is seen in a number of countries in sub-Saharan Africa, mainly Malawi, Zambia, Nigeria, Kenya, Ethiopia, Ghana, Rwanda, Burkina Faso, Senegal and Nigeria (Jayne & Rashid, 2013). According to Mason and Ricker-Gilbert (2013) and Takeshima and Lee (2012) input subsidy programs are strategies used to foster the African Green Revolution. These subsidies are also given in an effort to lower consumer prices of key staple foods, to stimulate agricultural productivity and thus to ensure food security (Maliro, 2011).

The standard economic theory describes the impacts of public agricultural policy such as input subsidies to likely result in an oversupply of subsidised inputs to farmers who are unable to use them efficiently and hence create a deadweight loss to society. A deadweight loss is defined by Takeshima and Lee (2012) as:

"A loss of economic efficiency resulting from misallocations of resources where goods are supplied at higher cost than the value they create and bought by those who extract less value from the goods than their cost, when their cost is valued at a non-subsidised price".

In addition, Stiglitz (1987) indicated that subsidies create a substantial financial burden and allocation inefficiencies for poor countries. Due to these reasons, development institutions and economists discourage the use of input subsidies.

During the 1980/1981 agricultural year, the Government of Lesotho (GoL) instituted an input subsidy scheme. The aim of the input subsidies was to achieve self-sufficiency in major staple foods such as maize, sorghum, wheat, beans and peas. However, the program was abandoned in 1996 because it failed to encourage development of a healthy productive economy as it led to market distortions and inconsistencies that proved to be costly to both beneficiaries and the government (MOAFS, 2003). It was also realised that production was not improving (GoL, 2000). In 2003/2004, the subsidy scheme in the agricultural sector was re-initiated but with the objective of comparative advantage. The input subsidy in 2003/2004 were given to poor households during extreme climatic conditions periods. This was planned to end in 2008/2009 (MOAFS, 2003).

In the 2009/2010 production season, the input subsidies were not abolished as planned but the government extended the program instead (FAO, 2012). However, the program was different in terms of its targeting. It was not targeted as the one implemented in 2003. The reason for the revival of the input subsidy program was an attempt to respond to household food shortages and to protect farmers from high international prices of fertiliser (World Bank, 2013). The goal of the program was to attain household food security through increased agricultural crop production. Consequently, this was hoped to improve the household's welfare (Central Bank of Lesotho (CBL), 2012b).

Agricultural production during the years of the subsidy seemed to be lower than when the subsidy was removed. Average production of maize, wheat and sorghum between the period 1980/81 and 1995/96 was 159,689 MT and between 1996/97 and 2002/03 was 196,541 MT (BOS & MOAFS, 2011). The fluctuations in production for most years have been attributed to the size of cultivated land and climatic variables. For instance, the high production levels observed between 1987/89 and 1989/90 were due to increased land planted. The low levels of production during the period 1990/91 to 1992/93 were a result of drought that hit the whole of Southern Africa (Mokitimi, 1995). The 1999/2000 production boom was explained by increased land under cultivation (FAO, 2002). In 2007/2008 low levels of production was attributable to drought while high production levels in 2009/10 was explained by the block farming initiative (CBL, 2012b).

Lesotho is among the poorest countries in the world where 77% of the population resides in rural areas and depends on subsistence agriculture for survival (WFP, 2011). As a result, a decline in agricultural output contributes to the increased share of population exposed to hunger and malnutrition. Furthermore, the low agricultural output contributes to high unemployment rates and a reduced farm income. Nationally, the low production creates a negative pressure on the country's balance of payments because of increased import bill (CBL, 2012b).

Agricultural production in Lesotho is not adequate to meet the country's consumption needs. Domestic cereal production only meets about 30% of the demand and the rest is import mainly from South Africa. For this reason, local food prices are more linked to South African prices (GoL, 2008). Households are vulnerable to high food prices, as their production does not meet their consumption requirement. Between March 2012 and March 2013 inflation increased by 6% (BOS, 2013a).

1.2 Problem statement

According to MOAFS (2005), one of the reasons for low agricultural production was the poor supply and use of agricultural inputs. This led to the inception of the agricultural input subsidy program as part of the government's intensive support for agriculture. However, the current and past trends in agricultural production in Lesotho do not show much of an improvement despite the existence of the fertiliser subsidy program. The fertiliser subsidy program has also been associated with inefficiencies in resource allocation. Economists and other opponents of the subsidies argue that the costs of these programs exceed their benefits to both the consumers and the producers in the market. Others have also questioned the way the government has been prioritising the distribution of these subsidies. Those who really need the assistance may not be the ones who are benefiting (WB, 2013). Furthermore, input subsidies are accused of not being sustainable as they put huge financial strains on government. The minister of finance on his 2013/14 budget speech indicated that at some point input subsidies would have to be eliminated as they are not sustainable (Ketso, 2014). Removing the fertiliser subsidy program will have consequences on households' welfare. Lack of information on these consequences impedes policies regarding subsidies in the agricultural sector. Therefore, this study aims to quantify the likely impact of removing the program and thus to contribute to the current debate and discussions regarding policy on subsidies.

1.3 Objectives and contributions of the study

The overall objective of the study is to assess the welfare effects of removing a fertiliser subsidy in crop production in Lesotho.

Specific objectives:

- To adopt an empirical framework to model the agricultural fertiliser subsidy policy in Lesotho.
- To determine the changes in production, consumption, household calorie consumption and agricultural income as well as the fertiliser demands brought by subsidy removal.

In achieving these objectives, the study is expected to make the following contributions:

- Add to existing literature on the case studies of input subsidy programs;
- Be a guideline to policy makers in Lesotho with regard to subsidies in the agricultural sector.

1.4 Methodology and Data

The objectives of the study were achieved by assessing the current fertiliser subsidy impact on production and consumption. In order to be able to understand the likely impact of removing the subsidy program, it is important to analyse the past trends of crop production with and without the program as well as the impact of the programs to related markets (non-food, livestock). For these reasons, the study makes use of the multi-market model. This model was first developed by Lundberg and Rich (2002) as a generic model for Africa. The model was calibrated with the data for Lesotho and the impacts of removing fertiliser subsidies were then analysed.

The study made use of several data sources. These include the Lesotho's Bureau of Statistics (BOS) for the production, input, income and consumption as well as income data. Data on prices of the commodities was attained from the FAO GIEWS and the Department of Marketing at Ministry of Trade and Industry, Cooperatives and Marketing (MTICM) while inputs (fertiliser) price data was obtained from the MOAFS. Trade data is obtained from the International Trade Centre (ITC)'s trademap and the FAOSTATS. Parameter data is obtained from various literature sources and guestimates.

1.5 Outline of the thesis

This thesis is organized into six chapters, whereby the first chapter introduces the study. The second chapter gives the literature on the theory of economic analysis of input subsidy. This literature chapter consists of the economic and non-economic rationale for input subsidies, the discussion on the welfare analysis, the analytical techniques and discussions on the theory of multi-market models. Chapter three provides the general understanding of the Lesotho national fertiliser input subsidy program. The chapter first gives the background to the Lesotho's agricultural sector and the input subsidy policy. In chapter four a brief description of multi-market model as applied in this study is given. This chapter consists of the information on sets used, data used and the limitations of the data as well as the limitations of the model. Chapter five presents the results generated from the model and results discussion. Chapter six gives the general summary, conclusions and recommendations drawn from this study.

2. Literature review

2.1 Introduction

The purpose of this chapter is to provide an understanding of the nature and economic theory behind input subsidies. Input subsidies are widely used tools by governments to achieve their developmental objectives. Subsidies use scarce public resources; therefore, it is crucial to understand the general economic implications they create in order to make sound policy assessments. In section 2.2, the economics of input subsidies are discussed. This is followed by the welfare evaluation of government policy intervention in section 2.3. Sections 2.4 and 2.5 discuss the rationale for input subsidies in terms of both economic and non-economic grounds respectively. Section 2.6 presents some of the analytical tools used to assess the impact of subsidy policies. This is substantiated with the literature on specific country applications. Lastly in this chapter before summary and conclusion is the description of the generic multi-market model to be applied in this study and an overview of case studies that applied it.

2.2 The economics of input subsidies

A subsidy is by definition financial aid or transfers from either the government or organizations to reduce the price of goods or services below their market values (Gupta, 2002). The amount of a subsidy is the difference between the market price of a good or a service and the actual price paid by farmers (Gupta, 2002; Monke & Pearson, 1989). The input subsidy affects production costs of the farmer by reducing the price paid by the farmer (Tokarick, 2003) thereby increasing the farmer's profitability (Chirwa & Dorward, 2013). Nevertheless, in a world of a perfectly competitive markets subsidies of agricultural inputs are not encouraged as they distort the allocation of scarce resources and inevitably result in economic inefficiencies and welfare losses (Crawford, Jayne, & Kelly, 2006; Druilhe & Barreiro-Hurle, 2012; Morris, Kelly, Kopicki, & Byerlee, 2007).

Economic efficiencies of agricultural policies are mostly measured by the change in an individual's welfare induced by the policy (Salhofer, 1997). The theory of economic behaviour serves as the basis for measuring the welfare changes and the deadweight losses induced by the policy intervention (Salhofer, 1997). This theory describes how a rational consumer allocates resources given limited budget constraints (Deaton & Muellbauer, 1980). One way of determining the consumer behaviour is to use a utility function to describe the individual's preferences with regards to her choice given limited resources. The assumption is that the consumer attempts to maximise utility subject to the scarce resources (Salhofer, 1997).

Analysis of subsidies takes the nature of a negative tax since they are direct transfers (Gupta, 2002; Legg, 2003). This implies that the effect of a subsidy on the quantity produced and quantity demanded is the opposite of the effect of a tax. A subsidy generally results in an increase in the quantity demanded of a subsidised good or service (Monke & Pearson, 1989; Takeshima & Lee, 2012).

Figure 2.1 gives the graphical illustration of the efficiency analysis of input subsidies under the assumption that there are no market failures and that the agricultural product produced with the subsidised input is non-tradable. It is also assumed that the relationship between the price of inputs and the supply of produce is non-linear shown by the shape of the supply curve on the figure.

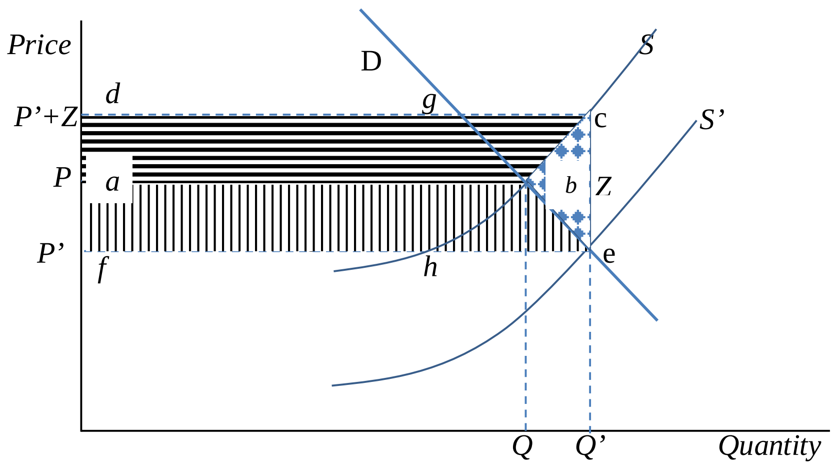

Figure 2.1: Input subsidy impacts on output supply, price and stakeholder welfare

Source: Dorward, 2009; Dorward and Chirwa 2013.

In a free competitive market without government intervention, the output market price is *P*, where demand curve D and supply curve S intersects, and quantity supply is *Q* as reflected in figure 2.1. The introduction of an input subsidy results in a downward and outwards shift of the supply curve *S* to *S'* due to a reduction in the costs of production. This causes supply to increase from *Q* to *Q'* resulting in a decline in the market price of the agricultural product from *P* to *P'*. The producer price increases at the same time to *P'* + *Z* as the producers will now be receiving the amount *P'* from the consumers plus the amount of the subsidy from the government.

After the subsidy is imposed, the consumers enjoy an increase in consumer surplus shown by the area indicated with the vertical lines (the area between the old price line *P* and the new market price line *P'* and below the demand curve *D*) in figure 2.1. Producers enjoy an increase in producer surplus denoted by the area marked with the horizontal lines, which is the area between the new producer price line *P'*+ *Z* and the original price line *P* and above the supply curve *S*. This means both the consumers and the producers are better off after the subsidy. However, the government is worse off as it incurs all the costs of paying for the subsidy. The line *Z* denotes the unit cost of the subsidy. The cost to the government is represented by the rectangle *cdfe*. Some of the costs of the government go to the consumer surplus while some goes to the producer surplus but there remain the costs represented area *cbe*, which are not accounted for. This area is the deadweight loss, which represents the inefficiency of the input subsidy.

2.3 Welfare measurement of government policy intervention

This section is limited to the ex-ante welfare measurement of government policy intervention. The core of the government intervention policy evaluation is to identify the individual groups or households and geographical locations to which the intervention may have the impact (Lundberg, 2005). This is because the degree and direction of the impact differs among different stakeholders even though all will be affected by the intervention. For example, the partial equilibrium analysis in the short term will result in net producers benefiting if there is a rise in a price of a commodity while net consumers will be negatively affected in the short-term. This will consequently affect the welfare. However, the general equilibrium analysis in the long term will have insignificant impacts if a price of a commodity is increased (Lundberg, 2005).

Following households or individual group identification is the assessment of the changes in production and consumption patterns induced by the intervention. The government market intervention changes commodity prices, which in turn influences the consumption and income decisions in households. A market reform that changes the price of a commodity will either change the household's production and consumption allocations or shift those productions and consumptions into their substitutes. A change in production affects household income and consumption. The magnitude and direction of the change are determined using own price and cross price elasticities calculated from household survey data (Lundberg, 2005).

Welfare is then deduced by evaluating the changes brought in employment, income, consumption and food security due to production and consumption changes induced by the government market reform. Income, employment, food security and consumption are regarded as indicators of welfare (Lundberg, 2005). Siam and Croppenstedt (2007) in their multi-market model approach to analyse the liberalisation of the Egyptian's wheat markets determined the welfare induced by market reforms by evaluating the changes in household calorie and per capita income changes as well as the changes in household consumption. According to Minot and Goletti (1998), prices of staple foods serve as an indicator of welfare, especially in less developed countries. This is because staple foods prices are professed to reduce real income of those households whose largest share of their budgets is spend on food. The indicators of welfare used in this study are similar to the ones used by Siam and Croppenstedt (2007).

However, measuring welfare has its own challenges as people have different perspectives of welfare; hence, indicators used differ from one study to another (Van de Walle, 1998). The confusion or conflict is drawn from the fact that welfare can be explained either in terms of income or in terms of the individual's preference as measured by utility or the capability of having access to certain needs such as education and food. Even with a single concept of welfare, the extent to which welfare is measured has to be clear. For instance, should the changes in income be evaluated over a single period or over several ones (Van de Walle, 1998). The analyst should therefore make a clear distinction of the welfare concept of the study.

Minot and Goletti (1998) used the multi-market spatial equilibrium model approach to assess the household welfare effect of liberalising rice export prices in Vietnam. They used household's income quartiles and other aspects of poverty as the indicators of the welfare. The measure they used to determine welfare differentiates farm prices and retail prices. The results of their study indicated that the majority of the Vietnam population are deficit producers of rice hence the reform increases inequality. However, the benefits of the intervention outweigh the costs as the average income of the poor increases thus causing deterioration in the incidence of poverty.

2.4 Economic rationale for input subsidies

As indicated in the previous section input subsidies are not encouraged on economic terms. However, in situations where it is believed that there are markets failures, input subsidies are encouraged to correct those failures (Druilhe & Barreiro-Hurle, 2012). The efficiency of input subsidies exists when the benefits of the provided subsidies outweigh the associated costs of such inputs (Takishima & Lim Lee, 2012; Dorward, 2009). Following is a brief discussion on conditions where input subsidies are considered significant on economic grounds.

2.4.1 Stimulate agricultural production

The subsidization of agricultural inputs is justifiable on economic grounds where domestic production is perceived to provide lower economic cost of food availability relative to food aid and food imports (Crawford et al., 2006). However, this condition depends on the availability of supply to meet increased demand of inputs due to reduced prices (Tsakok, 1990); and the efficiency of input use, as well as the weather conditions (Dorward & Chirwa, 2011). In addition, the ability of input subsidies to raise agricultural production depends on the application of all the necessary farming techniques (Dorward & Chirwa, 2011). In other circumstances, inputs subsidies are economically justified if the low productivity of agriculture is a result of some underlying market failures (Wiggins & Brooks, 2012).

2.4.2 Compensate for high costs of inputs

There are conditions where the usage of productive inputs is inhibited by high costs created by a distance from a port or a manufacturing factory of such inputs. In that situation, subsidization of inputs to offsets those costs is justified (Wiggins & Brook, 2012). Another reason that justifies the subsidization of agricultural inputs is the inability of smallholder farmers to afford high input prices due to poverty and limited access to credit (Takeshima & Lim Lee, 2012; Wiggins & Brook, 2012). Furthermore, inputs subsidies are used to offset high costs of supplying inputs when markets have low volumes and economies of scale in logistics cannot be achieved (Wiggins & Brook, 2012).

2.4.3 Correct negative externalities

In situations where there are economic costs associated with soil fertility depletion that do not enter into farmer's financial calculations, subsidization of inputs such as fertiliser is justified (Morris et al., 2007). Negative externalities arising from soil fertility depletion include increased soil erosion and decline of downstream water quality supplies deforestation and loss of biodiversity from expansion of cultivation into forested areas and marginal lands. In addition, loss of carbon to the atmosphere, which contributes to global warming, is another negative externality (Morris et al., 2007; Crawford et al., 2006). However, this argument can however be contested against the fact that organic manure can achieve the same goal with lower costs (Morris et al., 2007).

2.4.4 Kick-start innovation and stimulate market development

On one hand when farmers have limited knowledge on the benefits of inputs such as fertiliser and or hybrid seed, subsidies may be used to speed up the adoption of such inputs (Dorward, 2009; Wiggins & Brook, 2012). On the other hand, farmers may be risk averse owing to market failures, such as lack of crop insurance as well as contracts and futures markets (Monke & Pearson, 1989). Consequently, this discourages the adoption of new technology or cash investment that carries financial risk. As a result, input subsidies are encouraged to speed up the adoption process (Crawford et al., 2006). Furthermore, subsidies may be given to suppliers of inputs in cases where input markets are weak or not available. In this case, subsidies are used to overcome start-up costs until a market reaches economies of scale (Morris et al., 2007). These conditions however, justify input subsidies only on a temporary basis provided the benefits of the subsidies outweigh the costs (Morris et al., 2007).

2.5 Non-economic justifications for input subsidies

There are circumstances where the subsidization of inputs is encouraged for reasons that are not economic. This according to (Crawford et al., 2006; Morris et al., 2007) are as follows:

- Social protection: To transfer income to farmers who are poor and live in remote disadvantaged areas (Stiglitz, 1987; Wiggins & Brooks, 2012);
- To alleviate poverty;
- To achieve food security;
- To overcome the unfair competition caused by producer protection in developed countries;
- Though not included in the objectives of input subsidies, the main drive for provision of input subsidies is the attainment of political power.

To achieve the non-economic objectives subsidies have to be targeted (Morris et al., 2007). This differs in terms of the objectives of the subsidies. In cases where the objective of the subsidy is to overcome the high costs of the inputs, subsidies should be targeted to those farmers who cannot afford fertiliser at market prices (Druilhe & Barreiro-Hurle, 2012; Jayne & Rashid, 2013). Economic rents in input subsidization accrue if subsidies are given to farmers who would afford inputs even if subsidies were not provided (Takeshima & Lee, 2012). When the reason for providing subsidies is to increase agricultural production, subsidies should be targeted to farmers who will use inputs effectively (Jayne & Rashid, 2013; Takeshima & Lee, 2012). Efficiency of input subsidies depends on both market failure and the elasticity of supply and demand (Dorward, 2009; Druilhe & Barreiro-Hurle, 2012).

2.6 Analytical techniques

This section gives different techniques used to analyse the impacts of input subsidies on agricultural production, food security or farmer's well-being. As mentioned, subsidies are analysed as a negative tax, therefore techniques that are used to measure the impact of a tax, measures the impact of a subsidy as well. Furthermore, a subsidy is a policy instrument; therefore, it is analysed with the same tools that are used to analyse policies. Methods used for measuring the economic impact of policy interventions discussed in this chapter range from the use of equilibrium models, policy analysis matrix (PAM) models and regression models. The effectiveness of these methods differs depending on the availability of relevant data and the objectives of the particular study.

2.6.1 Equilibrium models

This section limits itself to the models that are based on an equilibrium supply and demand. Supply and demand quantities for each given market are represented by functions of price and other variables. Equilibrium is given by equating quantity supplied to quantity demanded in each market (Briones et al., 2012). These models are either static or dynamic. Static equilibrium models allow supply and demand to balance within a single time period and can be distinguished according to the scope of equilibrium being computed while dynamic equilibrium models allow supply and demand to be determined over multiple periods (Briones et al., 2012; Shoven, 1992).

Equilibrium models are divided into two segments, being the general equilibrium models and the partial equilibrium models. General equilibrium models attempt to simulate the operations of the complete set of goods and factor markets and institutions of the entire economy. Partial equilibrium models attempt to simulate only a subset of the real economy often omitting factor markets altogether. Partial equilibrium models can in turn be divided into multi-market models and single-market models (Van Tongeren, Van Meijl, & Surry, 2001). In multi-market models price variables affect supply and demand of different commodities while in single market models, the supply and demand of a commodity is only affected by its own price (Briones et al., 2012).

2.6.1.1 Partial equilibrium models

Partial equilibrium models emphasised in this section are the multi-market equilibrium models. However, a brief description of the partial equilibrium models in general precedes the discussion. Partial equilibrium models are most widely used to assess the effect of various policy interventions on the agricultural sector. They are applicable where the sector is relatively small in the economy, inputs are mainly specific to the sector and competition for factors with other sectors is limited (Gebrehiwet, Meyer, & Kirsten, 2011). Thus, they consider the agricultural system as a closed system without linkages with the rest of the economy (Van Tongeren et al., 2001). As indicated on the introductory part of this section, partial equilibrium models are either single-market or multi-market models. The disadvantage of the single market models is that they do not consider the substitution effect of the commodities (Arulpragasam & Conway, 2003).

Multi-market models are predominantly suitable in policy analysis that change the price of a good or commodity under analysis. Examples of such policy analysis include the removal or inclusion of a subsidy and the addition or withdrawal of a tariff or quota (Arulpragasam & Conway, 2003). They are used to give the ex-ante estimates of the effect of the policy or the external shock on prices either on the welfare or the incidence of poverty. They provide more results that are accurate when the commodity analysed has a clear set of close substitutes or complements in either the demand or supply side. In addition, confidence in interpreting the results drawn from the multi-market models is determined by the accuracy of the supply and demand functions' parameters as well as the price demand parameters. These parameters need to be estimated econometrically from the country's household and production surveys. In cases where data are not sufficient in estimating the parameters, parameters used can be obtained from the literature of other countries similar to the one under study or the best guesses of the experts. However, the results obtained from the use of such parameters can be interpreted with less confidence (Arulpragasam & Conway, 2003; Sadoulet & De Janvry, 1995).

A multi-market model is a static model and is therefore based on fixed parameters. Sensitivity analysis has to be performed in order to determine the responsiveness of the results to the parameters used. This is done by using different parameters and comparing the resultant changes on the results. The sensitivity analysis helps in guiding the analyst to estimate the bounds of the coefficient in building the model (Arulpragasam & Conway, 2003).

A limitation of multi-market model over the computable general equilibrium (CGE) model is that the multi-market model does not incorporate labour independently but assumes that output is produced by employing household members while the CGE separates households and labour. This omitting of labour in multi-market results in bias when estimating welfare (Siam & Croppenstedt, 2007).

Partial equilibrium models are widely used in the analysis of the impact of input subsidies. Dorward and Chirwa (2013) developed a partial equilibrium model to analyse the impacts of the Malawi Farm Input Subsidy Program (FISP) on smallholder livelihoods in two major and contrasting livelihood zones for the period 2005/06 to 2010/11. The findings indicated that the program has contributed in increased maize production and real income in those regions. They concluded by pointing out that the indirect benefits of the FISP are greater than the direct benefits as the program lead to increased farm wages and reduced food prices.

Beghin, Bureau and Park (2003) applied a multi-market model of Korean agriculture and food markets to estimate the response of supply and demand to the government intervention and the resulting welfare effects. The Korean government intervened in major agricultural markets by imposing tariffs, providing input subsidies as well as the consumer subsidies. The objective of the intervention was to attain self-sufficiency in food production and hence food security. Their findings indicated that these distortions result in welfare losses in Korea and they concluded by pointing out that food security could be achieved through production targets and open borders without welfare losses.

In their study, Hedley and Tabor (1989) investigated the beneficiaries of a fertiliser subsidy in Indonesia and the resulting impacts on farmers and crop production of removing the subsidy. The assessment of the effects of removing the subsidy was achieved using the multi-market econometric model. Their investigations revealed that the main beneficiary of the subsidy were the suppliers of fertiliser and not the farmers. The analysis found that the subsidy creates an economic loss to the economy as a whole.

2.6.1.2 Computable general equilibrium (CGE) models

The CGE models functions by simulating the interactions of different sectors that make up an economy. This is done by using behavioural equations to represent the sectors and their contribution in an economy is assumed to be at optimum. The complete set of demand and supply in all the markets need to be specified (Robinson, 1989). The equality between expenditures and incomes are always satisfied by the whole economy in computable general equilibrium modelling, a feature not applicable to the partial equilibrium modelling (Sadoulet & De Janvry, 1995). A standard computable equilibrium model is static in nature; however, a dynamic dimension can be added if some exogenous variables are updated and some observed behavioural changes depend on the previous solutions (Burfisher, 2011; Sadoulet & De Janvry, 1995).

CGE models use social accounting matrices (SAMs) as a database for their empirical structure. SAMs provide details of the basic accounting entities needed for the economy to be in equilibrium (Hertel, 2002; Lundberg, 2005). CGE models are suitable in analysing policies that are purported to have huge indirect and second-round effects. In addition, it has the ability to capture the macro-economic policy impact on real exchange rate, remuneration rate as well as the resource allocation (Sadoulet & De Janvry, 1995).

CGE models fall short over the multimarket models by their huge data requirements and complexity (Siam & Croppenstedt, 2007) and hence consume a lot of time to compile (Lundberg, 2005). Therefore, CGE models need not to be used if policies under evaluation do not lead to structural changes and do not have large macro-economic impacts (Lundberg, 2005). Alternatively, multi-market models fall short over CGE models in that they assume labour as part of household.

Warr and Yusuf (2014) on their study of fertiliser subsidy and food self-sufficiency in Indonesia applied a computable general equilibrium model to compare the effects of fertiliser subsidy policy to those of import tariffs on rice and restrictions on importation of rice policies. The study aimed to analyse the effects of these policies on the structure of household welfare and hence, poverty levels. Their results indicated that a fertiliser subsidy lowers the domestic price of rice and increases the wages of unskilled labour relatively more compared to tariffs and import restrictions on rice. In conclusion, they pointed out that although fertiliser subsidies are not efficient tools for reduced poverty levels, they are much better when compared to import quotas and tariffs.

De Migual and Manresa (2008) used a static computable general equilibrium analysis to determine the impact of the removal of farm subsidies to the Extremadura economy. The results indicated that the removal of farm subsidies results in high production costs and a reduction in agricultural factor demand. This resulted in a rise in consumption prices of agriculture-linked sectors such as food, beverages and tobacco. In general, the simulation results of a complete removal of farm subsidies in Extremadura showed a fall in welfare due to the reduction in disposable income and a rise in investment or savings prices.

2.6.2 Policy analysis matrix (PAM)

The policy analysis matrix is a product of two accounting identities; one defining profitability as the difference between revenues and costs and the other measuring the effects of divergences (policy distorting and market failures). The basis of evaluation is on theoretical assumptions, empirical simplifications and a thorough understanding of its underpinnings. The methods using this approach allow for the analysis of the impacts of policy on producer income, identification of transfers among key interest groups; producers in agricultural systems, consumers of food and policy-makers controlling allocations of the government budget. The empirical method to estimate policy analysis using a PAM consists of the use of supply and demand curves for various inputs and outputs as well as the usage of budget formulation for representative farms, marketing and government revenue. This is useful in determining profitability of farms and comparative advantage of farm systems as well as the manner in which additional public investment might change the pattern of efficiency (Monke & Pearson, 1989; Nelson & Panggabean, 1991).

A PAM differs from partial equilibrium models in that the measure of efficiency in a PAM is social returns while in partial equilibrium models it is measured by subtracting the social benefits increments from the increments of social costs. A PAM takes into account all the contribution of social benefits to the national income while partial equilibrium considers the change brought by the price policy when measuring efficiency (Monke & Pearson, 1989).

The limitation of a PAM as a tool for policy evaluations is that it does not take account of non-efficiency objectives of government intervention and generate results that are not realistic in a dynamic sense and potentially biased against government policies (Yao, 1997). The other drawback for PAMs is that it is static and thus policy simulations do not permit the response of supply in relation to price changes. Another drawback for PAM is that it only accounts for consumption efficiency losses in direct subsidies and ignores them in other aspects where policy could have an impact (Monke & Pearson, 1989). A PAM also does not take account of income distribution, government revenue as well as the effect of taxes and subsidies on either consumption or production (Siam and Croppenstedt, 2007).

Najafi (2005) used PAM to determine the effects of the Iranian government policy intervention on wheat production. The government of Iran protected its producers by provision of inputs subsidy (fertiliser, seeds and pesticides) in wheat production and its consumers by bread subsidy. The findings indicate that this government’s involvement has caused the land under cultivation of wheat to decline which results in low production and a rise in wheat imports. Consequently, farmer’s income dropped during the period under study. He concluded that producer’s profits could be enhanced without the intervention and advised the government to rather improve infrastructure and research and development.

YAO (1997) analysed the costs and benefits of Thai government's agricultural diversification policy using PAM. Under the policy, the government cut on the production of rice and other traditional agriculture to encourage diversification into soybeans, horticulture and cattle farming. This was done by subsidising inputs on production of crops that replace rice production. The results indicate that rice is a more suitable crop for Thai agriculture and cutting its production creates inefficiencies in resource allocation.

2.6.3 Regression models

Regression models are econometric tools used to analyse the functional relationship between variables. The relationship is expressed in the form of an equation or a model connecting the dependent variable and explanatory variables. The regression models are used to evaluate the importance of policy that are changing values of explanatory variables or to forecast values of the dependent variable for a given set of explanatory variables (Chatterjee & Hadi, 2012; Pindyck & Rubinfeld, 1998). Applications of regression models have been used on various disciplines, for example in the field of input subsidies. Like other analytical techniques, regression models have their disadvantages as an indicator of policy analysis. Their data requirement is very demanding in terms of historical and empirical data sets. This implies that their ability to isolate specified intervention depends on the availability of data (Chirwa & Dorward, 2013). In cross sectional studies, regression analysis requires large datasets to enable the estimation of elasticities and the use of panel data, which are often not available. This is especially the case for less developed countries (Kaimowitz & Angelsen, 1998).

Ricker-Gilbert and Jayne (2012) applied quintile regression to household panel data in Malawi in an effort to estimate the effects of fertiliser subsidy on maize production. The study further aimed to investigate how a fertiliser subsidy program would lead to poverty alleviation. Their findings indicate that the Malawi Farm Input Subsidy Program does not have the capacity to boost production and at the same time reduce poverty. This is due to the nature and design of the program. It is indicated that the targeted objectives of boosting maize production and alleviating poverty would be achieved by targeting the subsidy to farmers who are able to produce effectively and use the inputs efficiently.

Osolio, Abrinigrum, Amas and Firdaus (2011) used a regression model to understand the relationship between fertiliser use and rice yields in Indonesia. The key objective was to estimate the extent to which a fertiliser subsidy increases rice production and to assess the impact that the removal of the subsidy would have on rice production. Their findings indicate that subsidization of fertiliser has positive impacts on rice production but at a very high public costs. Further, the results show that the fertiliser use increases rice yields to some point, beyond which it results in an overuse of the fertiliser; and thus leads to distortions.

Mason and Smale (2013) tested the hypothesis that subsidies on hybrid seed change maize production; total household income; the severity of poverty as well as relative deprivation among smallholder maize growers in Zambia. A nationally represented longitudinal data of a sample of 3200 smallholder maize growers was used. The econometric results indicate that an increase of 10kg subsidised seeds increases harvested maize by 106kg and income by 1.1% and it reduces the severity of poverty by 0.7%. In general, hybrid seed subsidies enhanced small farmers in Zambia but by small magnitude. Similarly, Maliro (2011) compared agricultural input subsidies and social cash transfers as policies for reducing vulnerability to hunger in Malawi and found that agricultural input subsidies reduce hunger but by a small magnitude.

All the reviewed analytical techniques have advantages and disadvantages in relation to their applications. However, the appropriateness of each technique is not based on superiority but on relevance within the given context. Given the policy focus in this study, the time and data limitation, a partial equilibrium multi-market model was deemed most appropriate and was therefore used as the measure of analysis.

2.7 The generic multi-market model

The generic multi-market model applied in this study is the one developed by Lundberg and Rich (2002) for Africa with the application in Madagascar. In developing the model, the first step is to classify and identify commodities and households categories to be included in the model (Arulpragasam & Conway, 2003). Households were categorised into urban poor, urban rich, rural poor and rural rich Products were classified into food crops, non-agricultural products, livestock and fertiliser (Lundberg & Rich, 2002).

Table 2.1: Product classification for the Madagascar model

PRODUCT	**ITEM**
Fine grains	Wheat and rice
Coarse grains	Maize, sorghum and millet
Roots and tubers	Potatoes, sweet potatoes and cassava
Cash crops	Coffee, tea, tobacco, spices and cocoa
Livestock	Meat production (cattle, poultry, pig)
Other foods	Miscellaneous of food products
Non-agricultural products	Forest products, manufacturing and other

PRODUCT	ITEM
	production
Inputs	Fertiliser

Source: Lundberg and Rich (2002)

The sets of elements used in the model are presented in table 2.2. Set C in the table represents all commodities used in the model. The subset I is a set of commodities other than fertiliser and the subset IA represents the crops. Sets IM represent importable products and IX represent exportable products. Food products are denoted by the subset F. The set NF denotes non-agricultural products, L represent livestock products and IN represent inputs, which is fertiliser in this case. Set H is a set of households groups used in the model. They include rural poor and rural rich, urban poor and urban rich.

Table 2.2: Sets used in the Madagascar multi-market model

Commodity	**Set/ Subsets**									
	C	**I**	**IA**	**IM**	**IX**	**F**	**NF**	**L**	**IN**	**H**
Fine grains	×	×	×	×		×				
Coarse grains	×	×	×			×				
Roots and tubers	×	×	×			×				
Cash crop	×	×	×		×	×				
Other food	×	×	×	×		×				
Livestock	×	×		×		×		×		
Non-agricultural	×	×			×		×			
Fertiliser	×			×					×	
Urban rich										×
Urban poor										×
Rural rich										×
Rural poor										×

Source: Lundberg and Rich (2002)

2.7.1 Structure of the model

The model incorporates six equation blocks: prices, supply, input demand, incomes, consumption and equilibrium conditions. The price block indicates the relationship between domestic producer prices and consumer prices. These prices are related to world prices for tradable goods and for non-tradable goods by the interaction of demand and supply. The supply block indicates the local production of food crops, non-agricultural products as well as livestock. The block for inputs presents the demand for farm inputs by the households. The income block shows farm income as the total of agricultural production income and non-agricultural income. The consumption block shows the household demand for food and non-food products. The equilibrium condition block indicates the equality between supply and demand for each of the product categories, ensuring that markets clear.

2.7.1.1 Price block equations

Producer prices (PP_c) are linked to consumer prices (PC_c) by the marketing margins ($MARG_c$) of commodities (c). The producer price (PP_c) is determined endogenously while the consumer price and the marketing margin ($MARG_c$) are determined exogenously. $DSUB_c$ represents domestic subsidy for all commodities (c).

Equation 1

$$PP_c = \frac{PC_c * (1 + DSUB_c)}{1 + MARG_c}$$

The price index ($PINDEX$) is determined by the weight on consumption ($PCWT_i$) given by the initial consumer prices ($PC0_i$) and the end of simulation price (PC_i). The subscript i represents all commodities in the model except fertiliser.

Equation 2

$$PINDEX = \sum_i PCWT_i * \frac{PC_i}{PCO_i}$$

For importable products (im) prices are indicated by the relationship between import prices (PM_{im}) and the marketing margins induced by transaction costs from border to domestic markets ($IMARG_{im}$) as well as the import subsidies ($ISUB_{im}$).

Equation 3

$$PC_{im} = \frac{PM_{im} * (1 + IMARG_{im})}{(1 + ISUB_{im})}$$

Prices for importable commodities (PM_{im}) are determined by linking the world price (PW_{im}) to the exchange rate (er), the international margins ($RMARG_{im}$) and the import tariffs (TM_{im}).

Equation 4

$$PM_{im} = PW_{im} * er * (1 + RMARG_{im}) * (1 + TM_{im})$$

Export prices (PX_{ix}) are shown by the relationship between the world price (PW_{ix}) for exports denoted by the subscript ix, the exchange rate (er) and the international margins ($RMARG_{ix}$) as well as the export tariffs (TE_{ix}).

Equation 5

$$PX_{ix} = \frac{PW_{ix} * er}{(1 + RMARG_{ix}) * (1 + TE_{ix})}$$

Consumer prices for export products (PC_{ix}) are related to the export prices (PX_{ix}) by the marketing margin of export commodities ($MARG_{ix}$) and the domestic subsidies ($DSUB_{ix}$) as well as the margin from markets to the borders ($IMARG_{ix}$).

Equation 6

$$PC_{ix} = \frac{PX_{ix} * (1 + MARG_{ix}) * (1 + DSUB_{ix})}{(1 + IMARG_{ix})}$$

2.7.1.2 The supply block equations

The share of land ($SH_{h,f}$) allocated to crop production in each household is indicated by the log linear function of producer prices (PP_f). The intercept $\alpha^s_{h,f}$ indicates the share of land allocated for crop production ($SH_{h,f}$) when producer price (PP_f) is zero. The coefficient $\beta^s_{f,h}$ denotes share elasticities and is interpreted as the change in household's share of land devoted to crop due to a one per cent change in the output price of that particular crop. The share of land is assumed to vary in each household and the sum of shares is one, indicating that all land is used.

Equation 7

$$\log SH_{h,f} = \alpha^s_{h,f} + \sum_f \beta^s_{f,h} \log(PP_f)$$

Crop yield for each household ($YLD_{h,f}$) in the model is indicated by the log linear function of crop output prices (PP_f) and the consumer prices (PC_{in}) for inputs denoted by the subscript in. The intercept is given by the coefficient $\alpha^y_{h,f}$ and it measures the value of household crop yield when the crop output price and the consumer price of the inputs is zero. The coefficient $\beta^{y}_{h,f}$ represents crop yield elasticities. This is interpreted as the change in household crop yield due to a one per cent change in producer price (*PP*) of the crop (*f*). The coefficient $\gamma^{y}_{h,f,in}$ indicate crop with fertiliser price elasticities and are interpreted as the change in household crop yield as a result of a one per cent change in the consumer price (*PC*) of fertiliser (*in*).

Equation 8

$$\log YLD_{h,f} = \alpha^{y}_{h,f} + \beta^{y}_{h,f} \log(PP_f) + \sum_{in} \gamma^{y}_{h,f,in} \log(PC_{in})$$

The household supply of food crops ($HSCR_{h,f}$) is determined by the total area used for crop production, the share of land ($SH_{h,f}$) allocated to each crop, and the associated yield ($YLD_{h,f}$) adjusted by losses through seeds and feeds and conversion factors *(conf)*. Conversion factor implies conversion of crop from harvesting to storage.

Equation 9

$$HSCR_{h,f} = \overline{Area} * SH_{h,f} * YLD_{h,f} * \overline{(1 - loss_f)} * \overline{conf}$$

The total food crop supply (SCR_f) is the summation of all food crops produced in each household ($HSCR_{h,f}$). The subscript *f* represents all the food crops used in the model.

Equation 10

$$SCR_f = \sum_{h} HSCR_{h,f}$$

Household livestock ($HSLV_{h,f}$) supply is represented as a log-linear function of the output cost of the livestock (PP_l). The intercept is indicated by $\alpha^{l}_{h\ l}$ is the value of household supply of livestock when the producer price of the livestock is zero. Livestock supply elasticities are indicated by $\beta^{l}_{h,l}$, in the equation and are interpreted as the change in household supply of livestock due to a one per cent change in output price (PP) of livestock (l) .

Equation 11

$$\log(HSLV_{h,l}) = \alpha^{l}_{h,l} + \beta^{l}_{h,l} \log(PP_l)$$

Total livestock supply (SLV) is the sum of household supply of livestock ($HSLV_{h,f}$).

Equation 12

$$SLV_l = \sum_h HSLV_{h,l}$$

Household supply of non-food ($HSNF_{h,nf}$) is a log-linear function of the cost of producing livestock. The alpha indicated as α_h^{nf} denotes the value of household supply of non-food ($HSNF_{h,nf}$) when producer price for non-food (PP_{nf}) is zero. Non-food supply elasticities are given by the coefficient $\beta^{nf}_{h,nf}$ that is interpreted as the change in household supply of non-food that caused by a one per cent change in the producer price (PP_{nf}) of non-food (nf).

Equation 13

$$\log HSNF_{h,nf} = \alpha^{nf}_{h,nf} + \beta^{nf}_{h,nf} \log(PP_{nf})$$

The total supply of non-food (SNF_{nf}) is the aggregation of households supply of non-food ($HSNF_{h,nf}$).

Equation 14

$$SNF_{nf} = \sum_h HSNF_{h,nf}$$

2.7.1.3 Input block equations

Household demand for fertiliser ($HDFERT_{h,in}$) is indicated by a log-linear function of crop output/producer prices (PP_f) and fertiliser prices (PC_{in}) paid at household level. The coefficient $\alpha^f_{h,in}$ is the intercept and it measure the value of household demand for fertiliser ($HDFERT_{h,in}$) when the producer price of the crop and the consumer price of the fertiliser are zero. The coefficient $\beta^f_{h,f,in}$ denotes the fertiliser demand elasticities. It is interpreted as the change in household demand for fertiliser (in) for a particular crop as a result of a one per cent change in the output price (PP_{in}) of that particular crop (f). The coefficient $\gamma^f_{h,in}$ represents own price fertiliser demand and is interpreted as the change in the household demand for fertiliser due to a one per cent change in the price of fertiliser (PC_{in}).

Equation 15

$$\log HDFERT_{h,in} = \alpha^f_{h,in} + \sum_f \beta^f_{h,f,in} \log PP_f + \gamma^f_{h,in} \log PC_{in}$$

The total demand for fertiliser ($DFERT_{in}$) is the summation of household fertiliser demand ($HDFERT_{h,in}$).

Equation 16

$$DFERT_{in} = \sum_{h} HDFERT_{h,in}$$

2.7.1.4 Consumption block equations

Household consumption (*$HC_{h,i}$*) is a log-linear function of consumer prices of commodities (*PC_i*) used by the household and the household income (*$YH_{h,i}$*). The coefficient α^h is the intercept and it measures the value of consumption when household income (YH) and commodity consumer prices (*PC_i*) are zero all else remaining the same. The coefficient $\beta^h_{h,i}$ represent the price demand elasticities and are interpreted as the change in household consumption brought about by a one per cent change in consumer price of a commodity. The coefficient $\gamma^h_{h,i}$ indicates income elasticities and are interpreted as the change in household consumption (*$HC_{h,i}$*) due to a one per cent change in household income (*YH_h*).

Equation 17

$$\log HC_{h,i} = \alpha^h_{h,i} + \sum_{i} \beta^h_{h,i} \log(PC_i) + \gamma^h_{h,i} \log(YH_h)$$

Total household consumption (*$CONS_i$*) is the aggregation of all products consumed by the household.

Equation 18

$$CONS_i = \sum_{h} HC_{h,i}$$

2.7.1.5 Income block equations

Agricultural income (*$YHAG_h$*) per household is the aggregation of income from food crops (*$SCR_{h,f}$*) and livestock (*$SLV_{h,l}$*) income less household expenditure on inputs (*$DFERT_{h,in}$*) and land tax. For Lesotho, the land tax is zero.

Equation 19

$$YHAG_h = \sum_{f} (PP_f * HSCR_{h,f}) + \sum_{l} (PP_i * HSLV_{h,l}) - \sum_{in} (PC_{in} * HDFERT_{h,in}) - \sum_{f} (AREA * SH_{h,f} * LANDTAX_{h,f})$$

Household income (YH_h) is the sum of agricultural income ($YHAG_h$) and non-agricultural income ($YHNAG_h$) adjusted by the price index ($PINDEX$). Non-agricultural income is determined exogenously.

Equation 20

$$YH_h = YHAG_h + \overline{YHNAG_h} * PINDEX$$

2.7.1.6 Market clearing condition

The market for each commodity (c) is cleared by equating supply and demand for that commodity. Supply consists of total crop supply (SCR_f), total livestock supply (SLV_l), total non-food supply (SNF_{nf}) and total net imports (M). Demand consists of human commodity consumption ($CONS_i$) and commodities used for animal feeds ($FEED_c$) as well as the demand for fertiliser ($DFERT_{in}$). Imports include private net imports (M_c) and the government imports ($GOVIMP_c$). Subsets *f, i, l, nf, in* are mapped into set C in GAMS using identity matrices.

Equation 21

$$\sum_f SCR_f + \sum_l SLV_l + \sum_{nf} SNF_{nf} + M_c + GOVIMP_c = \sum_i CONS_i + \sum_{in} DFERT_{in} + \overline{FEED_c}$$

2.7.1.7 Objective equation

The model is solved by minimising the dummy created objective function *omega*. This is because there is no distinct entity in GAMS to specify the function to be minimised or optimised (Rosenthal, 2014).

Equation 22

$$omega = 10$$

2.7.2 Studies that applied the generic multi-market model for Africa

The model was first developed by Lundberg and Rich (2002) to assess policy changes in Madagascar. Though it was applied to Madagascar, the model was designed as a generic model that can be used for a number of African countries. Scenarios simulated include 20% increase in rice production, 20% fertiliser subsidies for all farmers and 20% fertiliser subsidies targeted for poor farmers, trade liberalisation and infrastructure improvement. The same model was also applied in Malawi to analyse agricultural policy changes (Lundberg and Rich, 2002b, as quoted by Ponce, Blanco, & Giupponi, 2014).

Stifel and Randrianarisoa (2006) modified the model to quantify different agricultural policies that can be implemented to ensure the wellbeing of households in Madagascar. They adjusted the model by including the seasonal component and singled out rice from the fine grains in product classification, as it is an important crop in Madagascar. The original model used only one input being fertiliser, but Stifel and Randrianarisoa added animal traction as a second input. This was done to reflect the true situation in Madagascar. They used simulation scenarios similar to those in the original model.

Siam and Croppenstedt (2007) built on the multi-market model of Stifel and Randriasanoa (2006) to assess the impact of liberalisation of Egyptian wheat markets, but they excluded the seasonality component of it. They only used crop commodities in Egypt and did not use the categories of other food, nor non-food. They also included labour in their model while Lundberg and Rich (2002) and Stifel and Randriasanoa (2006) excluded this factor in their models as they surmised that it is better studied in CGE models. The scenarios simulated include complete liberalisation of wheat markets, 20% increase in wheat import price, substituting imports with strategic stocks as well as the 10% increase in wheat yield coupled with a 10% reduction in the marketing margin.

2.8 Summary and conclusion

This chapter presented the preview of literature related to the input subsidy programs. A subsidy is a payment made by either government or organization in order to reduce price of a good or service paid below their market value. The most stated reasons for governments (mostly from developing countries) to provide subsidies of the agricultural inputs are to boost production, attain food security and ultimately alleviate poverty. In addition, subsidies are given with the aim to distribute income and to correct some market failures. Some of the reasons for input subsidies are economic while others are either social or political.

On economic grounds, subsidies are not encouraged as they inevitably lead to distortions. Efficiency analysis of subsidies considers their effect in changing demand and supply curves. Inefficiency in subsidy analysis is indicated by the size of the deadweight loss. This is discussed in section 2.2. However, subsidisation of agricultural inputs is economically justified on the grounds that it encourages farmers to use new technology and when local production is proved to be cheaper than imports. Again, agricultural input subsidies are acceptable if there are negative externalities and if the usage of the inputs is inhibited due to high transactional costs created by some market failures.

In analysing the welfare implications of input subsidies, it is important to specify the indicators of welfare as individuals have different perceptions of welfare. To some welfare can be analysed in terms of income or food security while in some instances it is measured in terms of ability to have education or access to good health services. In this study, the indicators of welfare used are income, consumption and calorie intake as well as price.

Analytical techniques used to measure the impact of agricultural input subsidy policy range from the use of equilibrium models, Policy Analysis Matrices and regression models. Equilibrium models are divided into partial and general equilibrium models. At sectorial level, the most appropriate technique among the equilibrium models is the partial equilibrium models. The effectiveness of the model depends on the quality of data used and the objectives of the study. Applications of PAM models are not popular in the analysis of the effects of input subsidy policies. In contrast, regression models and partial equilibrium models are the techniques mostly applied in agricultural sector policy analysis.

Each technique has its merits and flaws depending on the nature and objective of the policy to be analysed. For example, partial equilibrium models have their merits in their smaller data requirement while they pose a major flaw in their assumption of the agricultural sector as a closed system. This is however the case in single-market partial equilibrium models. The multi-market partial equilibrium models consider the interaction of both agricultural and non-agricultural markets in their analysis. Again, their disadvantage is a larger data requirement. Regression models gain advantage in agricultural policy analysis when adequate data is available. The CGE models are complicated and require huge data set as well.

The analytic model to be applied in this study is the generic multi-market model developed by Lundberg and Rich (2002) for African countries. It consists of six blocks of equations specified for different households for all commodities included in the model. The equations include prices, supply, inputs, consumption, income and the market clearing conditions. The model data incorporates production, prices and income of households as well as the demand for input. The model also makes use of elasticity data. It is crucial to perform sensitivity analysis in order to measure the responsiveness of the results to elasticities used. There are a few instances in the literature on studies that applied this model. These include applications on Madagascar and Egypt.

3 Lesotho national fertiliser and input subsidy program

3.1 Introduction

The aim of this chapter is to put the Lesotho national fertiliser and input subsidy program in context. The first section introduces the chapter. The next section gives an overview of the agricultural sector. This is followed by a discussion on the input subsidy policy program in section 3.3. The discussions include information on the past policies and the current fertiliser subsidy policy. In section 3.4 the link between fertiliser subsidy, production and fertiliser demand is given. Lastly, in the chapter is the summary and conclusions.

3.2 The Lesotho Agricultural sector

The kingdom of Lesotho is a small country in Southern Africa with a population estimate of 1,894,194 in 2011. More than 72% of the population of Lesotho resides in rural areas and survive mainly on informal economic activities (BOS, 2013b). Agriculture is the main occupation for most of the rural inhabitants and the main contributor to rural income. In 2012, the largest contributor to rural income was farming. Contrary, for the urban dwellers the main source of household income is wages and salaries from the private sector (BOS, 2012b). About 52% of the working population of Lesotho in 2012 was formally employed while approximately 21% of the population was subsistence farmers (BOS, 2012b).

Lesotho's total land area was estimated to 30,355 km^2, which is equivalent to 3,035,500ha in 2007. About 76% of the total land was agricultural land. About 10% was suitable for arable and permanent crops and 66% for livestock rearing (Matsoai, Bader, Razes & Dop, 2010). During the 2012/2013 agricultural year the total area planted to major crops (maize, sorghum, wheat, beans and other foods) was 172,859ha and the total area fallow was 73,632ha (BOS, 2013a). Maize dominates other crops in terms of the size of the area it covers followed by sorghum, beans, wheat and other foods respectively (figure 3.1).

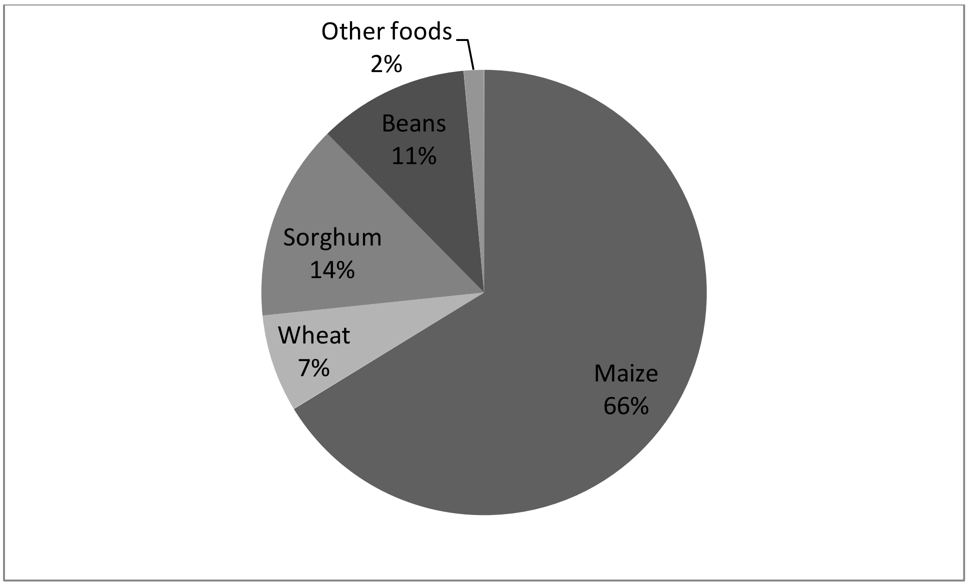

Figure 3.1: Area planted in Lesotho to major crops in 2012/2013

Source: BOS (2013a)

The agricultural sector in Lesotho is mainly subsistence farming with minimal commercial farming. The main agricultural activities are crop production and livestock rearing. Crop production dominates the agricultural sector (MOAFS, 2006). Agricultural years run from August to July and summer crops consist of mainly maize, sorghum and beans whereas winter crops are mostly wheat and peas. Wheat is a summer crop in the mountains zone (MOAFS & BOS, 2011). Livestock rearing predominantly consists of cattle, sheep, goats, donkeys and horses on extensive range management. Dairy, poultry, pigs, ducks and rabbits are kept around the homes. The main agricultural exports in Lesotho are wool and mohair (MOAFS, 2006). Livestock production is a substantial contributor to rural income. Because Lesotho is a mountainous country, most of its terrains are suitable for livestock production (MOAFS & BOS, 2011).

Crop production in Lesotho is mostly rain-fed as irrigation possibilities are limited (Van Schalkwyk, Van Zyl, Botha, & Bayley, 1997; Matsoai et al., 2010). This is despite the fact that Lesotho has abundant water for export. It is argued that Lesotho's topography inhibits the profitability of the land that can be irrigated (Turner, 2009). The share of crop production to the agricultural GDP is higher than that of other agricultural activities. For instance, in 2007 crop production accounted for 70% of the agricultural GDP and the remaining 30% was accounted for by livestock and other agricultural practices (Lienberg, Shiferaw, Golebiowski, & Montembault, 2007). The most commonly cultivated crops are maize, wheat and sorghum.

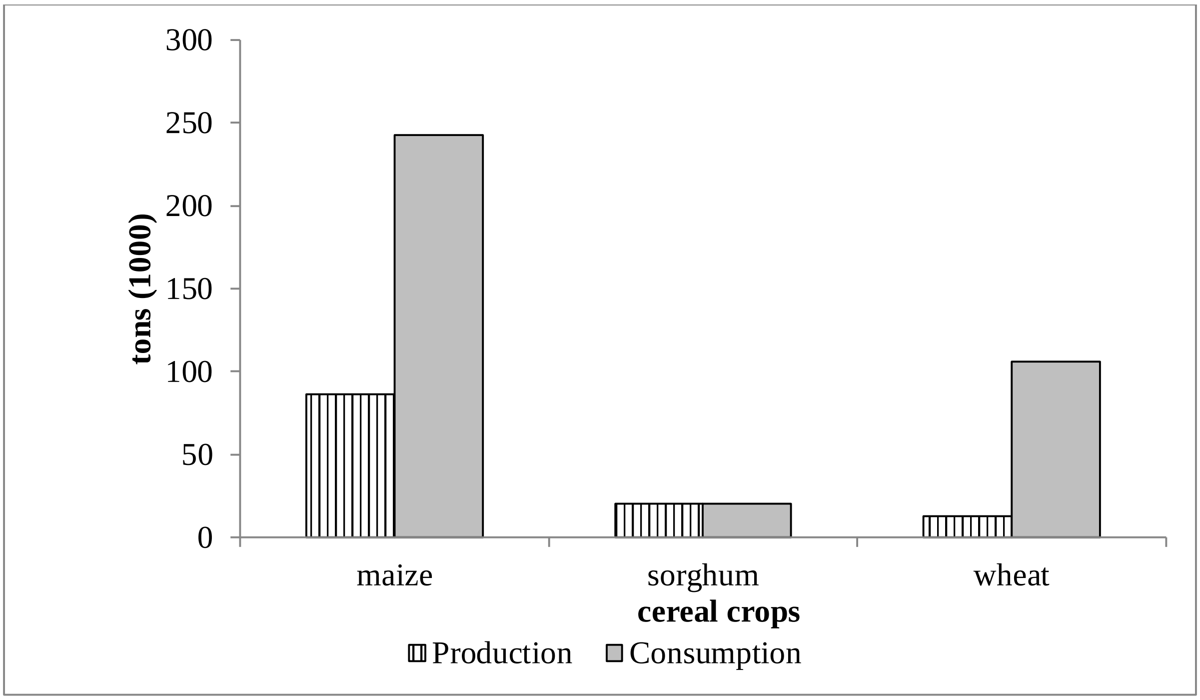

Figure 3.2: Production and consumption of major field crops in Lesotho in 2012/2013

Source: BOS (2013a)

Figure 3:2 shows the composition of production and consumption of Lesotho's major crops for the year 2013. It can be noted that maize is the major crop produced and most consumed. Sorghum falls second in terms of production but it is the least consumed. Wheat production in Lesotho is low compared to the consumption and production of other field crops. According to the SADC REWU (2003), cereals comprise about 75% of the total calorie intake whereby maize accounts for 49%, wheat 17% and sorghum 9%. At that time, the average per capita consumption of maize was 115kg and that of wheat was 30kg per year. The average per capita consumption of maize in Lesotho was 174 kg per year on average in 2014 (IITA, 2014). According to Matsoai et al., (2010) the dietary energy supply in Lesotho between 2003 and 2005 was 2,425kcal per capita per day. This comprised of 11% protein and lipids and 77% carbohydrates. This further proves the high dependency of cereals in Basotho diet. The population dietary energy requirement in 2005 was 2,137kcal per person per day.

Lesotho is generally a deficit crop producer with imports exceeding production by more than half, except for sorghum (figure 3.3). As a result, the country is vulnerable to international food price shocks (CBL, 2012a). Food prices are influenced most by price changes in South Africa as more than 70% of food consumption is made up of imports from South Africa (CBL, 2012a; Leduka et al., 2015). Households are more dependent on markets for their consumption needs than for household production (Lienberg et al., 2007; Matsoai et al., 2010).

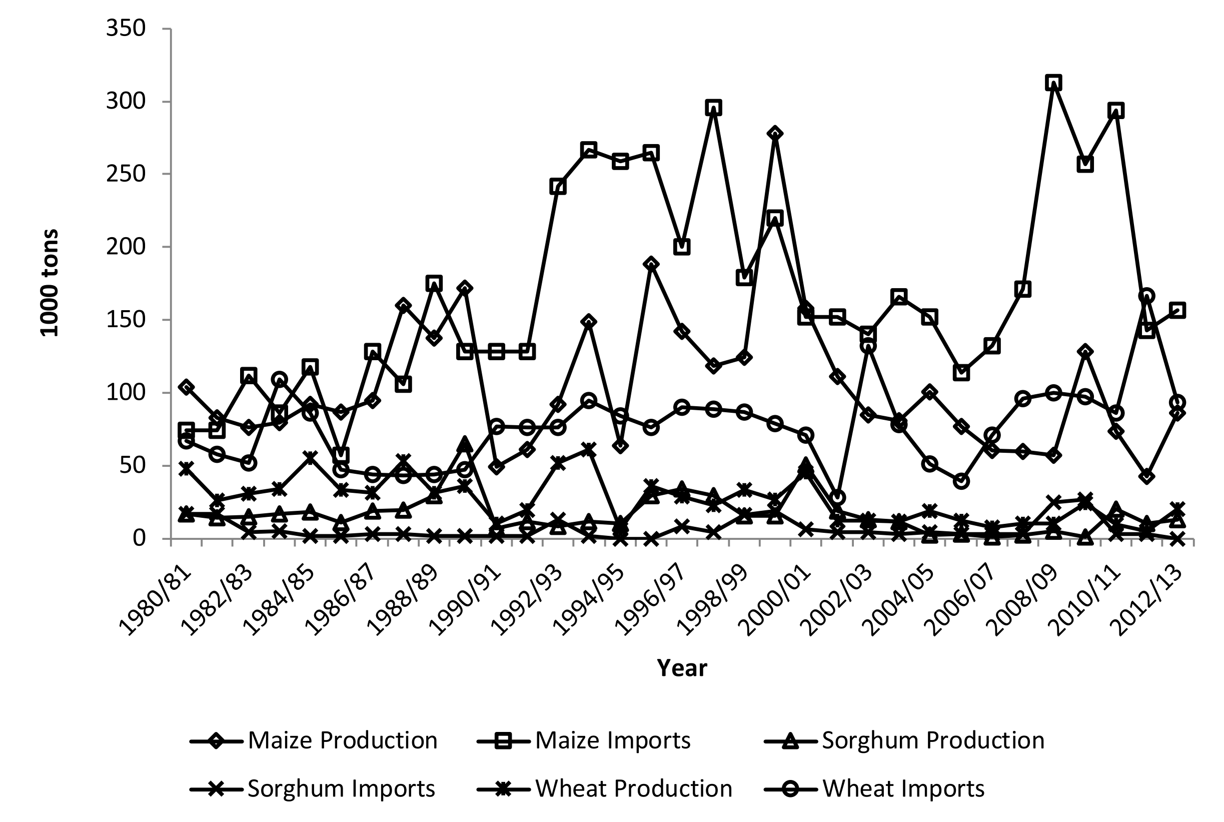

Figure 3.3: Trends in major crop production and imports in Lesotho (tons) between 1980 and 2013

Source: BOS (2013c, 2014a) and FAOSTATS (2015)

Figure 3.4 shows yields of main field crops in Lesotho. As can be seen, wheat yields showed the greatest increase between 2009 and 2103, while bean yields decreased. However, the land planted to wheat is small compared to other field crops. This might be because wheat is a winter crop in lowlands where most of the arable land is concentrated. Wheat is a summer crop in the mountains region where arable land is limited. Yields in Lesotho are relatively low compared to those of subsistence farmers in South Africa under dry land condition. For instance, in 2012/13 the average white maize yield for small scale farmers in South Africa was about 2.1tons/ha (DAFF, 2013) and in Lesotho for the same year the average maize yield was 0.89tons/ha.

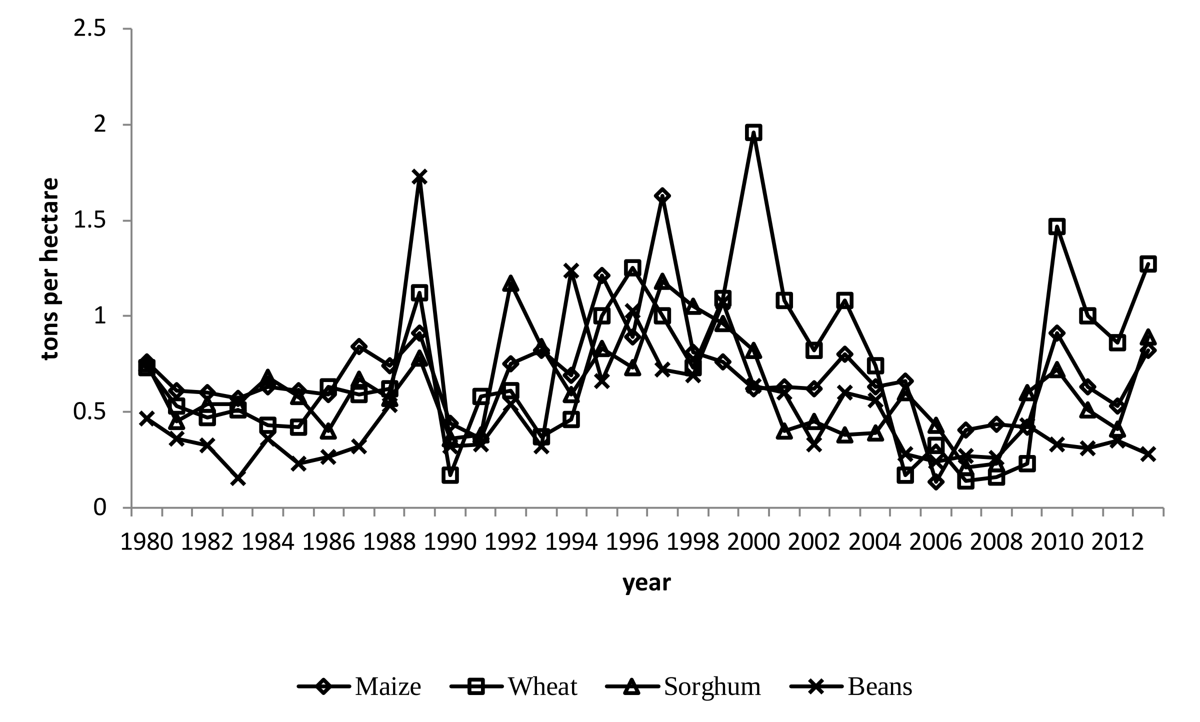

Figure 3.4: Yields of major crops (tons/ha) in Lesotho between 1980 and 2013

The poor performance of the agricultural sector is attributed to the decline in arable land due to soil erosion and increasing human settlement on agricultural land (MOAFS, 2005). In addition, Lesotho's topography makes it vulnerable to recursive droughts and prolonged floods. For example, during the production year 2006/07 low production was explained by drought while in 2011/12 low production was attributed to floods that swept away most crops (MOAFS & BOS, 2011). Poor supply and use of inputs are also contributors to the low agricultural production (FAO, 2012). This is attributed to the unavailability of inputs at the right time and place. Poorly developed rural infrastructure marketing facilities such as roads, traders and storage is professed to be major contributors. Again, farmer's lack of working capital and inadequate knowledge of the best way of using inputs are other contributors to the low input use and supply (MOAFS, 2005). Furthermore, the heavily reliance on maize plantation is professed to contribute to low agricultural production. This is because maize plantations are found to be unsuitable for Lesotho but it covers the majority of the cultivated land (Matsoai et al., 2010; World Bank, nd). In addition, the reduced income due to the retrenchment of migrant workers in South African mines contributes to the failing agricultural production in rural villages where the majority of the population resides (MOAFS, 2003.

3.3. Input Subsidy Programs in Lesotho

3.3.1. Historical overview

The input subsidy program in Lesotho started back in 1980/81 agricultural year under the Food Self Sufficiency Project (FSSP). The FSSP was created with the aim to attain self-sufficiency in the main staple food crops, mainly maize and sorghum (MOAFS, 2003; GoL, 2000). During that time, the self-sufficiency concept was reflected in the thinking of development; and hence supported by the development institutions. Moreover, the concept was also encouraged because of the uncertainties associated with food supplies, as Lesotho feared that South Africa might decide to close its borders because of the apartheid system that prevailed at that time. Self-sufficiency was also supported because the government wanted to reduce dependency on migrant labour's income and to attain rural income through agricultural production. Other measures that the government used to achieve self-sufficiency were the protection of local farmers from foreign competition through import controls and other regulations on market participants (MOAFS, 2003).

However, the government realised that its involvement in the agricultural sector creates market distortions and inconsistencies that proved to be costly to both the government and the consumers (MOAFS, 2003). The FSSP resulted in government budget deficits and macro-economic imbalances. In addition, the concept of an input subsidy was perceived to create a culture of dependence on government. Furthermore, input subsidies and supplies had discouraged farmers to take appropriate farming decisions, as they were often not distributed in time for the planting season (MOAFS, 2003). In 1996 the FSSP was cancelled when government realised that agricultural production was decreasing even more than prior the introduction of subsidy. Moreover, this contributed to government failing to meet its objective of self-sufficiency in agricultural production.

Upon cancellation of the FSSP, new subsidy policies were drafted with conditions that subsidies would only be provided in years when there is low agricultural production due to climatic shocks, such as drought and floods. The re-drafted subsidy policy was first implemented in 2002/2003 and was to run for 5 years up to 2005/2008 (FAO, 2003). The policy was aimed at encouraging commercial production where comparative advantage existed and to enhance food security of the poor (MOAFS, 2003). The subsidy policy consisted of different kinds of subsidies. These include subsidies in the form of inputs, development of infrastructure such as irrigation and development of land improvement activities. Input subsidies were only targeted to vulnerable households as temporary remedy after disasters like floods or extreme droughts, to enable them to regain productive capacity. The Ministry of Agriculture worked with the Department of Disaster Management Authority (DMA) in selecting the beneficiaries (MOAFS, 2005).

3.3.2. Current National Fertiliser and Input Subsidy Program

The current Lesotho National Fertiliser and Input Subsidy program started in 2009/2010 cropping season. The objectives of the program are to attain food security through increased agricultural production, to promote fertiliser use and to protect farmers from the impact of huge international fertiliser prices increases (World Bank, 2013). It is fully funded by the Government of Lesotho and the amount allocated differs on a yearly basis in accordance with the money allocated to the agricultural sector. In 2009/10 the amount spent on the program was M59 million[1] which is equivalent to approximately US$8 million and 9200 tons of subsidised fertiliser were purchased (MOAFS, 2013). In the 2010/11 cropping season the program cost the government only M18 million, which is equivalent to US$2.6 million. The reduction in the amount allocated to the program in the 2010/11 cropping season was a result of the previous year's subsidised stock that was carried over to the next year (2010/11) (World Bank, 2013). In the 2011/2012, agricultural year the money spent on the purchase of inputs was M27.3 million, which is equivalent to US$3.8 million (MOAFS, 2014).

The subsidised fertiliser in the 2012/2013 production year amounted to 5,663 tons. This has led to the total cost of M118 million (US$14.4 million) of which M107.9 million (US$13 million) was used to purchase inputs and the remaining M10 million (US$1.2 million) was the cumulative administrative costs (MOAFS, 2014).

Input subsidies under the current program are not targeted but are available to everyone in the country at a price ranging between 30% and 50% of the retail price. The rate of the subsidy is determined annually. In 2012/2013, the fertiliser subsidy rate was 50%, which was M110.00 per 50kg bag, compared to a market price of M250.00 per 50kg bag. The government buys inputs in South Africa and sells them to private traders at a reduced price. The private traders are subsequently mandated to sell inputs at a fixed price to farmers (World Bank, 2013).

It is not evident whether the program is successful or not, but the Minister of Finance during the 2014/2015 fiscal year budget speech pointed out that agricultural production in 2012/2013 tripled the previous year's production and forecasts predict much higher production in 2014/2015 because of the subsidy program. He further concluded:

[1] M stands for Maloti (singular: Loti), a currency for Lesotho. It is pegged to the South African Rand on a 1:1 basis through a Common Monetary Area.

"This means that the policy intervention aimed at improving food security and therefore reducing hunger is yielding positive results. I should however indicate that in the long run, the programme should be aimed at helping the farmers to be self-sufficient as this kind of financing might not be sustainable and in principle, subsidies are not intended to be permanent"(Ketso, 2014).

Nevertheless, the Lesotho Fertiliser and Input Subsidy Program is criticised by World Bank (2013) for its inefficiencies and for creating distortions. The arguments against the programs include the following:

- Targeting: The untargeted nature of the program results in efficiencies as scarce public resources are transferred to farmers who do not need them. Since this program is costly, subsidies should be targeted to poor farmers who cannot afford to buy fertiliser at its commercial price.
- Leakage: The total amount allocated to the program is not adequate to meet the country's demand for fertiliser; thus, those who accessed it first bought in bulk and then resold back to those who could not get access. In addition, it is presumed that the leaked inputs are sold into South Africa at a low price.
- Regressive: The program is alleged to create inequalities as it benefits the well-off farmers relatively more than the poor. This is indicated by the low distribution of the subsidised fertiliser to the mountains region where poor people are located.
- Crowd out private sector: The program is regarded to undermine the development of a network of private traders since retailers and importers are unwilling to invest in stocks of fertiliser and seed because of the uncertainty regarding government sales and pricing.
- Rent seeking behaviour: This is the activity of influencing the political process to obtain favourable outcomes or to avoid unfavourable ones (Schmitz, Moss, Schimitz, Furtan, & Schmitz, 2010).

3.4. Fertiliser demand, subsidies and agricultural production

Crops in Lesotho are mainly fertilised by synthetic fertiliser and manure made from animal droppings and plants composts. Manure, specifically animal ones, is predominantly used in the country despite the government's efforts to subsidise chemical fertilisers. This might perhaps be due to the fact that the majority of the farming population is poor and hence cannot afford even the subsidised fertiliser prices. Figure 3.5 shows the total area of land that was fertilised with chemical fertiliser and animal manure for the agricultural years from 2009/2010 to 2012/2013. The figure indicates that over these years the proportion of land fertilised with chemical fertiliser is less compared to that fertilised with animal manure. 'Organic' in figure 3.5 represents the area fertilised with animal manure while 'inorganic' represents the area that is fertilised with chemical fertiliser.

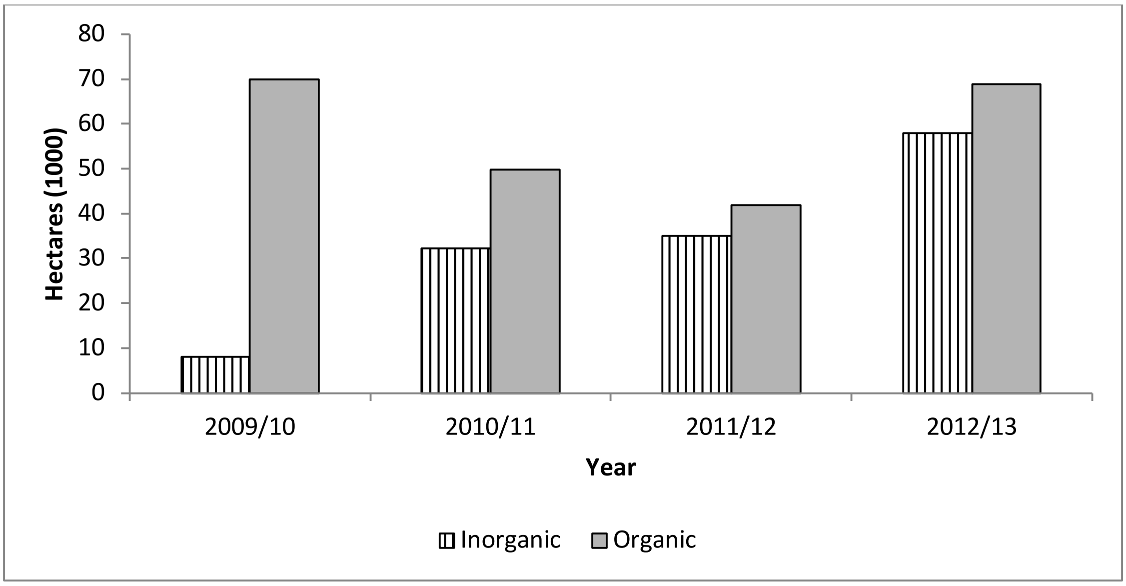

Figure 3.5: Area fertilised (1000 ha) in Lesotho between the years 2009 and 2013

Source: BOS (2012a, 2014a)

The growth rate of fertiliser consumption in Lesotho from the period 1970 to 2002 was 11.67% making Lesotho the country with the second highest growth rate of fertiliser usage in Africa (Camara & Heinemann, 2006). However, the level of usage was still low compared to other neighbouring countries. For instance, in 2002, fertiliser consumption in Lesotho was 34.24kg per hectare and in Swaziland it was 39.33kg per hectare, while Malawi and South Africa used 43kg/ha and 65.42kg/ha respectively (Camara & Heinemann, 2006). According to the Abuja declaration during the 2006 Africa fertiliser summit that was held in Abuja, Nigeria, the recommended fertiliser use is 50kg per hectare.

The fertiliser consumption in the 2012/2013 agricultural production year was 7,819 tons on a total area of 172,859ha (BOS, 2013a). Thus fertiliser consumption was 45kg/ha. According to the FAO (2002), the fertiliser demand in Lesotho is influenced by climatic conditions, as farmers do not plant when there is no rain.

Table 3.1: Fertiliser demand (ton) and price (M/50kg bag) in Lesotho for 2009 till 2013

Year	**Unsubsidised (ton)**	**Subsidised (ton)**	**Used (ton)**	**Price (M/50kg bag)**	
				***SP**	****UP**
2009/10	68,941	5,663	74,604	105	250
2011/12	0	9,200	8,049	105	298
2012/13	2,622	5,197	7,819	110	400

Year	**Unsubsidised (ton)**	**Subsidised (ton)**	**Used (ton)**	**Price (M/50kg bag)**	
				***SP**	****UP**
2013/14	0	9,040	173	160	330

*Subsidised price and **unsubsidised price

Source: MOAFS (2014), BOS, MTICM (2014)

The ‘unsubsidised’ column in table 3.1 denotes the fertiliser purchased from private traders and is determined by subtracting the subsidised fertiliser from the used fertiliser in cases where it exceeds the subsidised fertiliser. The ‘used’ column is the fertiliser reported by the BOS while the ‘subsidised’ column indicates the quantity of fertiliser imported by the MOAFS. The MOAFS does not have records on how much fertiliser they have distributed. It is therefore, believed that the difference between the total fertiliser used and the subsidised fertiliser is the amount of unsubsidised fertiliser. One could note that in the agricultural years 2011/2012 and 2013/2014 the value of subsidised fertiliser exceeds the total value of fertiliser used. This might be due to the late arrival of the subsidised fertiliser or that some farmers could not afford the subsidised price. Prices are the average prices of 3:2:1(25) and 2:3:2(22) type of fertilisers. These two types constituted much of the chemical fertiliser consumption in Lesotho during the period indicated in table 3.1. In the 2009/2010 agricultural year, the block farming scheme was in operation hence the high usage of fertiliser. Block farming was a government initiative of encouraging commercial farming by lending farmers money to buy agricultural inputs. The loans were secured through Standard Bank with the government as the guarantor. The block farming scheme was launched in the 2006/07 agricultural year and was abandoned before the production season started in 2010/11 because farmers were not paying off their loans (CBL, 2012b).

Generally, agricultural production in Lesotho has always been subsidised since 1980. Figure 3.6 shows that there is little or no relationship between maize production and the availability of a fertiliser subsidy considering that maize is the most subsidised. The said reason for high production in 1999/00 of increased cultivated land (FAO, 2002) shows that it was not prompted by the fertiliser subsidy as the fertiliser subsidy were not available during that year. In addition, the level of production in 2009/10 when compared to the consumption of fertiliser in that year, is low. The subsidy in 2002/03 did not result in increased production either.

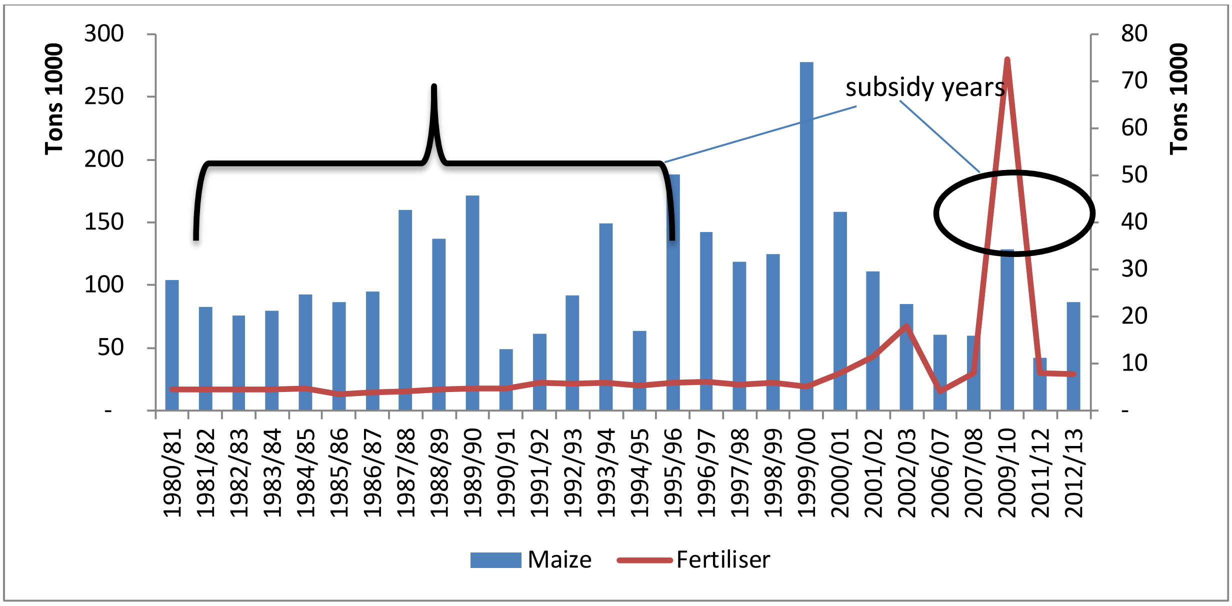

Figure 3.6: Fertiliser demand and maize production (tons) in Lesotho between 1980 and 2013

Source: MOAFS & BOS (2011), BOS (2013a) and Econ Stats (2014)

3.5. Summary and conclusion

This chapter presented a brief review of the Lesotho's National Fertiliser and Input Subsidy Program. Lesotho is a small country in southern Africa with the majority of the population living in rural areas. Farming activities are the main source of income for rural households while urban households' income is dependent on wages and salaries.

Lesotho's terrain is mostly mountainous with only 10% of the land arable. Agricultural crop production, which is mainly rain-fed, consists mainly of maize, sorghum, wheat, beans and peas. It contributes more to agricultural GDP than other agricultural sectors. Maize is the crop that is consumed and produced most in the country. Livestock production includes mainly cattle, sheep, goats, poultry and piggery. Livestock production contributes to rural income mainly through the exportation of wool and mohair.

Agricultural production in Lesotho is declining due to the poor supply of inputs, unfavourable weather conditions; deteriorating arable land, etc. This has resulted in increased poverty, unemployment and reduced share of agriculture to GDP. As a result the government intervened by providing a 50% subsidy on the price of fertiliser. The usage of fertiliser in 2012/2013, which is the base year for this study, was higher compared to previous years.

Agricultural crops in Lesotho have been subsidised since 1980 with the goal of attaining food self-sufficiency in cereal production. This self-sufficiency program was dropped at the end of 1996 because it was believed to distort the markets and to create a culture of dependency by farmers on the government. During 2003/04 the government reintroduced the subsidy scheme with the aim to boost the commercial sector and to improve food security of the poor. The program ran through the period 2003/2004 to 2008/2009, during which input subsidies were only provided as remedy after natural disasters.

The current subsidy program commenced in the 2009/10 agricultural year. The main objective of the program is to obtain food security and to protect farmers from the relatively high and volatile international fertiliser price. The subsidy rate is 50% and is given to every farmer in the country and are thus not targeted. The subsidy programme is aimed to run for a short period though it is not clear when it will end. The program is being criticised by the World Bank for its inefficiencies and putting huge financial strains on the government. Nevertheless the Government of Lesotho believes that they are already harvesting the rewards of the program.

The link between the fertiliser subsidy and production (represented by maize) seemed to be non-existent. This is because levels of production are high during the period when the fertiliser subsidy is not available, and when more fertiliser is used the production levels are not consistent with what one would expect.

4. The Lesotho multi-market model

4.1. Introduction

This chapter presents the methodology applied in this study. The study uses the multi-market model developed by Lundberg and Rich (2002) for Africa and calibrates the data for Lesotho. The next section gives the model details. These include the software used, the household and product groupings as well as the model sets. The third section discusses data and data sources, followed by sections on the data limitations and model limitations. The last section summarises and concludes the chapter.

4.2. The model

The structure adopted in this model is the one developed by Lundberg and Rich in 2002 and is discussed in chapter 2 section 2.7.1. The base model assumes a perfect subsidy program as it does not incorporate losses due to late delivery of the inputs, targeting or administrative costs. It assumes a 50% subsidy on fertiliser in the base case. The model solutions are computed through the incorporation of the GAMS software that makes use of a Non-Linear Programming (NLP) solver. The name of the NLP solver used is the CONOPT 3 version 3.16C (GAMS Development Corporation, 2014). The GAMS code used was obtained from Professor Rich.

4.2.1. Product description

Product categories in this model are classified into the following:

- **Maize** is the main staple food in Lesotho. It is regarded as the backbone of the food security policy in Lesotho. Maize production covers the largest area under cultivation and is the product most consumed by most households. Therefore, its production receives the greatest subsidised. It is also an important importable product because production is not sufficient to meet domestic demand.
- **Wheat** follows maize as the most consumed crop in the country. Its production does not meet the required consumption; hence, it is an important importable crop as well. Wheat and maize are substitute products on the consumption side even though maize consumption outweighs that of wheat. Wheat is a winter crop while maize is a summer crop; however they still compete for land as the maize planting season starts before wheat can be harvested.
- **Sorghum** is second after maize as the most cultivated crop in Lesotho. It is mostly sold in the domestic market. It is hardly imported and imports are low if imported (figure 3.3). Therefore, it is treated as a non-tradable commodity. Sorghum and maize are both summer crops hence they are substitutes on the production side. They compete for resources such as land and inputs.

- **Cash crops** consist of dried beans. Beans are grown with commercialisation in mind hence are regarded as cash crops. The Household Budget Survey (HBS) 2010/2011 report refers to beans as industrial crops (BOS, 2014e). However their production is minimal and Lesotho is a net importer of beans and peas.
- **Inputs** only include chemical fertilisers in the model. Lesotho does not produce its own fertilisers, making it expensive for local farmers. It also forms a major part of subsidies in the agricultural sector policy document.
- **Livestock** consists only of broilers in this model. Chicken meat is the cheapest to obtain among all the meat products. Therefore it is mostly consumed especially in urban households.
- **Non-food** consists of wool and mohair. These commodities are the main contributor to rural income with wool dominating. Wool and mohair are also Lesotho's main agricultural exports.
- **Other food** includes an aggregation of green leafy vegetables such as spinach and cabbage. These are consumed complemented by maize meal porridge. They make up a daily diet in most households, especially poor households.

Table 4.1: Sets used in the model

Commodity	**Set/ Subsets**									
	C	**I**	**IA**	**IM**	**IX**	**F**	**NF**	**L**	**IN**	**H**
Wheat	×	×	×	×		×				
Maize	×	×	×	×		×				
Sorghum	×	×	×			×				
Cash crops	×	×	×		×	×				
Other foods	×	×	×			×				
Livestock	×	×				×		×		
Non-food	×	×			×		×			
Fertiliser	×			×					×	
Urban rich										×
Urban poor										×
Rural rich										×
Rural poor										×

Source: Own compilation

Set *C* is a set of all commodities used in the model. These include wheat, maize, sorghum, cash crops, other food, livestock, non-food and fertiliser. Subset *I* represents all commodities in the model besides fertiliser. The subset *IA* consists of all the crops in the model. Imports denoted by the subset *IM* consists of wheat, maize, and fertiliser. Export products include cash crops and non-food and are indicated by the subset *IX*. The subset *F* is a subset of all the food products and these consist of wheat, maize, sorghum, cash crops, other food and livestock. The subsets *L* and *NF* represent livestock and non-food respectively and *IN* stands for inputs (fertiliser). Set *H* is a set of households used in the model and they are discussed in the next section.

The selection of set elements are important as it relates to certain model assumptions, for example domestic prices of internationally tradable products are assumed to remain unaffected by changes in input costs, i.e. changes in the price of fertiliser, as these prices are assumed to be determined by the international prices.

4.2.2. Household classification

Households are broadly classified into urban poor and urban rich; rural poor and rural rich. It is assumed that all households are engaged in agricultural activities but to different degrees. In addition, it is assumed that both consumer and producer prices paid in rural areas are similar to prices paid in urban areas. Again, prices paid by poor and rich households are the same.

Households were selected through the use of the 2011/2012 Continuous Multi-Purpose Survey (CMS) from the Bureau of Statistics (BOS). The data was already classified into rural and urban areas. The Stata version 13 statistical software (StataCorp LP, 2013) was used to create a dummy variable representing the poor and rich households. Average income was used as a benchmark to separate the poor from the rich households, with those households with income below average classified as poor and the ones above average income as the rich. Four household groups were ultimately created, the rural poor and the rural rich; the urban poor and the urban rich.

The data sample had 4,577 observations, of which 2,118 were rural and 2,446 were urban households. Several studies suggested the use of survey weights when dealing with sample data (Wittenberg, 2009). Therefore, this study made use of probability weights to make the sample calculations representative of the whole population. The average household size for the rural households was 4.8 and that of urban households was 3.4. The sample was representative of the total population of 69,135 poor households in urban areas and 196,171 poor households in rural areas. The total population size of rich households in urban areas was 42,111 and rich households in rural areas were 40,245 giving a total population of 347,662. These numbers are presented in table 4.7 section 4.3.1.5

The Agricultural Production Survey dataset was merged with the Continuous Multi-Purpose Survey dataset. This enabled the Agricultural Production Survey data to be categorised into production by poor and rich households from both urban and rural areas. The agricultural production survey dataset has information on production of maize, wheat, sorghum, cash crops and inputs only. Therefore, livestock, non-food (wool and mohair) and other food were incorporated into the household categories by estimations based on the livestock products report and the urban agricultural survey report. These datasets and reports were all obtained from the Bureau of Statistics (BOS).

4.3. Data and data sources

There are three types of data required in conducting the model: levels, prices and parameters.

4.3.1. Levels

The level of production, consumption, inputs and income data should be specified for all household groups and commodities. Agricultural production and fertiliser data were obtained from the agricultural section of the Bureau of Statistics (BOS, 2013b) of Lesotho. Consumption and income data were obtained from the 2012 Continuous Multi-Purpose Survey (CMS). Trade data for 2013 were obtained from the International Trade Centre’s (ITC) Trademap and the FAOSTATS database.

4.3.1.1 Area planted

The total area planted (table 4.2) to production of major crops in 2012/2013 production season is 172,859ha. Out of the total area planted 12,100ha was planted to wheat and 112,258ha was planted to maize. Most land was used in the production of maize and by poor household groups. Sorghum follows maize for the most cultivated land and its plantation is concentrated in rural households. Other food is the least planted crop with its plantation mostly in urban households. However, it should be noted that land cultivated is given in BOS reports as land used per crop not by household groups.

Table 4.2: Area planted (ha) in Lesotho in 2012/2013

Household	Wheat	Maize	Sorghum	Cash crops	Other food	Total
Urban rich	3,457	17,286	1,729	5,186	1,729	29,386
Urban poor	2,247	17,286	5,186	3,457	1,383	29,559
Rural rich	3,803	43,215	10,372	6,914	1,037	65,341
Rural poor	2,593	34,572	6,914	3,457	1,037	48,573
Total	12,100	112,358	24,200	19,014	5,186	172,859

Source: Own calculation based on BOS (2014b)

4.3.1.2 Production

On average per capita household production of the rich is higher than that of the poor households for all products. Among the crops maize production dominates that of other crops. The land planted to maize and the fertiliser applied to it is higher than that of other crops. Production of sorghum follows that of maize in all the household groups. Wheat production is higher than that of cash crops even though the area planted to cash crops is higher than the one planted to wheat. Other food is the least produced.

Table 4.3: Household production (HSCR, HSLV, HSNF) (kg/capita) in Lesotho in 2012/2013

Household	Wheat	Maize	Sorghum	Cash crops	Other food	Livestock	Non-food	Average
Urban rich	87	307	35	23	32	11	28	75
Urban poor	33	206	60	8	11	5	6	47
Rural rich	102	881	234	31	21	9	42	189
Rural poor	14	128	28	3	3	3	4	26
Average	59	381	89	16	17	7	20	84

Source: Own calculation based on BOS (2014b)

Table 4.4: Household production (HSCR, HSLV, HSNF) (tons) in Lesotho in 2012/2013

Household	Wheat	Maize	Sorghum	Cash crops	Other food	Livestock	Non-food
Urban rich	3,683	12,913	1,454	979	1,348	1,348	1,178
Urban poor	2,301	12,754	4,120	526	761	760	415
Rural rich	4,114	35,471	9,403	1,263	850	851	1,705
Rural poor	2,676	25,188	5,428	589	622	622	773
Total	12,774	86,325	20,405	3,357	3,582	3,581	4,070

Source: Own calculation based on BOS (2014b)

4.3.1.3 Yield

As assumed, rich households have higher yields for all the crops and wheat yields are higher than that of other crops. Yields of other food and cash crops are the lowest among the crops. Maize yields are the lowest when compared to other cereal crops (wheat and sorghum) though it is the most planted and fertilised. This only shows that maize production is not profitable when compared to other crops.

Table 4.5: Household crop yield (HYLD) (tons/ha) in Lesotho in 2012/2013

Household	Wheat	Maize	Sorghum	Cash crops	Other food	Average
Urban rich	1.29	0.81	0.90	0.31	0.78	0.82
Urban poor	1.24	0.80	0.85	0.25	0.55	0.74
Rural rich	1.31	0.89	0.97	0.30	0.82	0.86
Rural poor	1.25	0.79	0.84	0.28	0.60	0.75
Average	1.27	0.82	0.89	0.29	0.69	0.79

Source: Own calculation based on BOS (2014b)

4.3.1.4 Fertiliser

Table 4.6 shows fertiliser data used as the base in this model. The data in the table do not differentiate subsidised fertiliser from unsubsidised fertiliser. It is the fertiliser used in the agricultural season of 2012/2013 on a total area of 172,859ha. The total fertiliser used in the 2012/2013 agricultural year was 7,818 tons of which 5,197 tons were subsidised by the government. According to the Agricultural Production Survey of 2012/2013 45kg was used per hectare of land (7,818 tons for 172,859ha).

Fertiliser usage is high for rural households with rich households consuming more than poor households. This is because these household groups produce on the largest share of land. Maize is the most fertilised crop followed by cash crops, sorghum and wheat. Less fertiliser is applied to other food.

Table 4.6: Household fertiliser demand (HDFERT) (tons) in Lesotho in 2012/2013

Household	Wheat	Maize	Sorghum	Cash crops	Other food	Total
Urban rich	56	149	28	18	6	257
Urban poor	63	260	49	31	10	413
Rural rich	260	3,910	737	472	46	5,425
Rural poor	126	1,209	228	146	15	1,723
Total	505	5,528	1,042	667	77	7,819

Source: Own calculation based on BOS (2014b)

4.3.1.5 Income

Table 4.7 gives the per capita average income of the population per household group. YHCAP in the table represents per capita household income, YHAGCAP denotes the per capita agricultural income, HH represent household numbers and POPHH is the population number per household. The average monthly income for the urban poor households in 2011/2012 was M737 and that of the rural poor households was M413. For rich households in rural areas the average monthly income was M6,787 while that of rich households in urban areas averaged to M4,350. These values correspond with the Household Budget Survey (HBS) of 2010/2011 though the HBS report does not have household groupings like the ones in this study. According to the HBS report about 93% of the population of Lesotho earned an average income of M404 per month between 2010 and 2011. About 3% of the population earned M4,313 per month and about 1% earned M7,216 per month. The report further stated farming as the major source of income nationally and in rural areas while in urban areas wages and salaries are the main sources of income. The value of urban poor households' average income is not surprising as the poor people in urban areas are mostly textile factory workers and their average income was M800 in 2011.

Table 4.7: Income (YHCAP), agricultural income (YHAGCAP) (M/cap/month); Household number and population (POPHH) in Lesotho in 2011/2012

Household	Income	Agric income	HH number	Population
Urban rich	4,350	237	830	42,111
Urban poor	737	158	1,288	69,135
Rural rich	6,787	1,002	427	40,254
Rural poor	413	347	2,019	196,171

Source: Own calculations based on BOS (2014c)

4.3.1.6 Consumption

Table 4.8 gives an illustration of per capita household consumption of all commodities in the model. Cereals are the most consumed of all the food products. This corresponds with reports that indicate that 80% of Lesotho diet is made up of cereals with maize dominating. All household groups according to this model consume relatively more maize than other cereals. Consumption of cereals is concentrated in rural areas and rich households consume relatively more than poor households. Rich households are consuming more than poor households for all products specified in the model. Poor households can barely afford to consume anything other than their own production because of their low incomes; hence, they consume less. This is more apparent in rural areas.

Table 4.8: Per capita household consumption (CONHCAP) (kg/capita) in Lesotho in 2011/2012

Household	Wheat	Maize	Sorghum	Cash crops	Livestock	Other food	Non-food	Total
Urban rich	747	1,190	97	49	28	29	7	307
Urban poor	341	836	59	15	19	21	4	185
Rural rich	684	1,627	203	44	29	30	20	377
Rural poor	120	354	21	5	6	5	3	73
Average	473	1,002	95	28	21	21	9	235

Source: Own calculations based on BOS (2012c and 2014c)

In table 4.9, the total household consumption is presented. It can be shown that maize consumption is greater for poor households than for rich households. This is not surprising as maize is the main staple food and hence consumption of staple foods is greater for poor households in most cases.

Table 4.9: Household consumption (HC) (tons) in Lesotho in 2011/2012

Household	Wheat	Maize	Sorghum	Cash crops	Livestock	Other food	Non-food	Total
Urban rich	31,446	50,092	4,084	1,193	2,064	1,227	306	90,413
Urban poor	23,585	57,799	4,078	1,330	1,037	1,468	287	89,584
Rural rich	27,514	65,505	8,162	1,182	1,771	1,223	795	106,152
Rural poor	23,584	69,357	4,080	1,191	981	980	611	100,785
Total	106,129	242,754	20,404	4,896	5,853	4,898	2,000	386,934

Source: Own calculations based on BOS (2012c and 2014c)

4.3.1.7 Calories

The calories used in the model were calculated using the conversions presented in table 4.10. Wheat represents brown steamed bread. Maize denotes hard white maize porridge popularly known as *papa* in Lesotho. This is a staple food. Sorghum represents sorghum hard porridge and cash crop denotes boiled dried beans. Livestock indicates boiled chicken while other food indicates boiled cabbage. Boiling is the popular method of cooking hence the selection of these recipes. The dietary energy supply was given in kilojoules per 100g of edible portion in the Lesotho food composition table (Lephole, Khaketla & Monoto, 2006). In this study the energy values are expressed in kilocalories per grams (Lephole, Khaketla & Monoto, 2006).

Table 4.10: Energy in kcal per gram (CAL)

Commodity	Kilo calories
Wheat	1.972
Maize	1.359
Sorghum	1.357
Cash crop	1.271
Livestock	2.204
Other food	0.229

Source: Lephole, Khaketla & Monoto (2006)

4.3.1.8 Trade

Table 4.11 shows the products imported and exported by Lesotho in 2013. Lesotho is a net importer of all the commodities in the table except for the non-food product. Maize was the most imported product in 2013. Data on trade of crops were obtained from the ITC's trademap (2013) and data on trade of livestock and non-food were obtained from BOS and fertiliser data were obtained from BOS and MOAFS.

Table 4.11: Trade (M) (tons) in Lesotho in 2012/2013

Commodity	Government imports	Private imports	Exports
Wheat	0	93,355	0
Maize	0	156,434	0
Sorghum	0	0	0
Cash crop	0	1,543	4
Other food	0	1,316	0
Livestock	0	2,272	0
Non-food	0	0	2,070
Fertiliser	5,197	2,622	0

Source: BOS (2014d), ITC (2013), MOAFS (2014)

4.3.2. Prices

Data on commodity prices were gathered from FAO GIEWS (2014) and data on input prices were obtained from the Ministry of Agriculture and Food Security (MOAFS) in Lesotho. Other prices are from the Department of Marketing at the Ministry of Trade and Marketing in Lesotho.

In table 4.12 a list of commodity prices that are faced by consumers and received by producers is given. Producer prices are lower than consumer prices for all commodities. The indicated fertiliser prices are the 50% subsidised price from the government. All prices are presented in Maloti per kg. It should be noted that in this study livestock is represented by chicken meat and non-food is represented by wool and mohair.

Table 4.12: Commodity prices (Maloti/kg) in Lesotho in 2012/2013

Commodity	Producer Price (PP)	Consumer Price (CP)
Wheat	4.96	5.7
Maize	3.79	4.36
Sorghum	3.72	4.28
Cash crop	23.48	27
Other food	2.73	3
Livestock	47.83	55
Non-food	83.33	100
Fertiliser	1.91	2.2

Source: FAO GIEWS (2014), MTICM (2014), MOAFS (2014)

4.3.3. Parameters

These represent supply and demand elasticities. There are no studies related to this conducted for Lesotho and no sufficient data to calculate parameters; therefore, data on parameters is mostly obtained from literature for Malawi (Simler, 2005). Due to lack of data and literature, other parameters are guesstimates mostly based on Madagascar model (Lundberg & Rich, 2002).

Malawi parameters used in this study are supply elasticities for deficit producers except for cash crop where supply parameters used are for surplus producers. Similar to Lesotho, maize is a major staple and dominates other crops in terms of area cultivated and fertilised. This is mostly a case for small-scale farmers (Likoya & Mangisoni, n.d). Land size for these farmers (deficit producers) is mostly less than a hectare in both Lesotho and Malawi. Agriculture is highly subsidised in these two countries though at a differing degree. It is for these reasons that the supply response in Malawi might be similar to that in Lesotho. Another reason for using Malawi parameters is that most of the studies using the multi-market model in Southern Africa used Malawi as a case study. Therefore, the available literature on parameters applicable to this study is Malawian case studies.

Malawi parameters were estimated through the use of the 1991 Food Security Nutrition Monitoring Survey (FSNMS). On one hand, the demand elasticities were estimated through the use of the Almost Ideal Demand System model. Because more of the observations had zeros in expenditure of the products probit models and Ordinary Least Squares (OLS) regression models were used to counteract for that. Probit models were used to estimate the probability of the binary dependent variables for the consumption of the product during the one-month recall of the survey. OLS regression models were used to estimate the relationship between consumption and price of the product, expenditure (representing income) and household size as well as the inverse of the mills ratio. On the other hand, the supply elasticities were estimated using different literature sources and economic theory. Sensitivity analyses were then carried out to determine the best set of elasticities (Simler, 2005).

4.3.3.1 Fertiliser price elasticities

Table 4.13 gives the data on input price demand elasticities as indicated by γ^f_h and $\beta^f_{in,f,h}$ in equation 15 (repeated in this section). The coefficient $\beta^f_{in,f,h}$ represents output price demand elasticities and is interpreted as the percentage change in the demand of fertiliser (*in*) for a one per cent change in the producer price (PP) of crop *f* (wheat, maize, sorghum, cash crop and other food) per household. The own price fertiliser elasticity ($\gamma^f_{h,in}$) is -1.26 and it implies that a one per cent increase in fertiliser price (PC) will result in a 1.26% reduction in demand for fertiliser (DFERT). Input demand elasticities with fertiliser are guesstimates based on those in the Madagascar model and they range between 0.1 and 0.3. The intercept $\alpha^f_{h,in}$ is calculated within the model given the information on demand for fertiliser (DFERT), prices (PP, PC) and elasticities ($\beta^f_{in,f,h}$ and $\gamma^f_{h,in}$).

Equation 15

$$\log HDFERT_{h,in} = \alpha^f_{h,in} + \sum_f \beta^f_{in,f,h} \log PP_f + \gamma^f_{h,in} \log PC_{in}$$

Table 4.13: Fertiliser price demand elasticities (EFE, EF)

Commodity	Own-price elasticity($\gamma^{f}_{h,in}$)	Output-price elasticities ($\beta^{f}_{in,f,h}$)
Fertiliser	-1.26	
Wheat		0.1
Maize		0.3
Sorghum		0.1
Cash crop		0.1
Other food		0.1

Source: guesstimates based on Lundberg & Rich (2002)

Elasticities of crop with fertiliser given by $\gamma^{y}_{h,f,in}$ in the yield equation (equation 8) are shown in table 4.14. They are interpreted as the percentage change in crop yield (*YLD*) per household due to a one per cent change in price of fertiliser (PC_{in}). The own-price elasticities of yield denoted by the coefficient $\beta^{y}_{h,f}$ in equation 8 are interpreted as the percentage change in yield of a crop *f* (wheat, maize, sorghum, cash crops and other foods) resulting from a one per cent change in the producer price (PP_f) of that particular crop. These are illustrated in table 4.15. Data were not enough to calculate these elasticities and there were no data in the literature either; hence, these values were obtained from Simler (2005). The intercept ($\alpha^{y}_{h,f}$) is derived within the model given the information on yield, elasticities and prices (PC_{in} and PP_f).

Equation 8

$$\log YLD_{h,f} = \alpha^{y}_{h,f} + \beta^{y}_{h,f} \log(PP_f) + \sum_{in} \gamma^{y}_{h,f,in} \log(PC_{in})$$

Table 4.14: Elasticity of crop with fertiliser (EYI) ($\gamma^{y}_{h,f,in}$)

Crop	Urban rich	Urban poor	Rural rich	Rural poor
Wheat	-0.1	-0.15	-0.1	-0.15
Maize	-0.2	-0.3	-0.2	-0.25
Sorghum	-0.12	-0.14	-0.13	-0.15
Cash crops	-0.1	-0.11	-0.1	-0.12
Other food	-0.09	-0.1	-0.09	-0.11

Source: Guesstimates based on Lundberg and Rich (2002)

Table 4.15: Crop yield elasticities (EYLD) ($\beta^{y}{}_{h,f}$)

Crop	Wheat	Maize	Sorghum	Cash crops	Other food
Wheat	0.2	0	0	0	0
Maize	0	0.35	0	0	0
Sorghum	0	0	0.2	0	0
Cash crops	0	0	0	0.5	0
Other food	0	0	0	0	0.15

Source: Simler (2005)

4.3.3.2. Income elasticities

The price elasticities given by the coefficient $\beta^{h}{}_{h,i}$ in equation 16 are interpreted as the percentage change in household consumption ($HC_{h,i}$) of commodity i resulting from a one per cent change in consumer price (PC_i) of that commodity. The coefficient $\gamma^{h}{}_{h,i}$ represent the income elasticities interpreted as the percentage change in household consumption of commodity i due to a one per cent change in income (YH_h) of household (h). The intercept $\alpha^{h}{}_{h,i}$ is derived within the model. Income elasticities are obtained from Elkof and Molapo (1987), except for the one for sorghum, which is a guesstimate. They range between 0.27 and 0.76 (table 4.17). Income demand elasticities for other food are represented by vegetables, livestock by meat and non-food by clothing in Elkof and Molapo's (1987) study. Income elasticities for poor households are represented by non-remittance receivers while those for rich households are represented by remittance receivers. Own price demand elasticity for maize is taken from Van Schalkwyk et al. (1997). Other price demand parameters are guesstimates based on Nganou (2004). These are shown in table 4.17.

Equation 16

$$\log HC_{h,i} = \alpha_{h,i}^{h} + \sum_{i} \beta_{h,i}^{h} \log(PC_i) + \gamma_{h,i}^{h} \log(YH_h)$$

Table 4.16: Income elasticities (EY) ($\gamma^{h}{}_{h,i}$)

Household	Wheat	Maize	Sorghum	Cash crops	Other food	Livestock	Non-food
Urban rich	0.32	0.41	0.40	0.53	0.63	0.53	1.12
Urban poor	0.30	0.29	0.28	0.55	0.66	0.55	1.16
Rural rich	0.46	0.75	0.60	0.50	0.47	0.50	1.12
Rural poor	0.44	0.56	0.52	0.76	0.53	0.76	1.16

Source: Molapo & Elkof (1987)

Table 4.17: Price demand elasticities (ED) ($\beta^{h}_{h,i}$)

Commodity	Maize	Sorghum	Wheat	Other food	Livestock	Cash crops	Non-food
Maize*	-0.51	0.04	0.07	-0.01	0.12	-0.09	0.04
Sorghum	0.12	-0.95	-0.11	-0.14	0.08	0.07	-0.28
Wheat	0.42	0.79	-2.84	-0.01	0.07	0.29	-0.01
Other food	0.39	-0.21	-0.07	-0.63	-0.05	-0.33	0.19
Livestock	0.51	0.09	-0.01	0.04	-1.44	0.24	0.01
Cash crops	-2.12	0.19	-0.78	0.20	0.93	-0.62	0.28
Non-food	0.71	-1.25	0.51	-0.01	0.01	0.32	-2.90

Source: * Van Schalkwyk et al. (1997), other elasticities are guesstimates based on Nganou (2004)

4.3.3.3. Land share elasticities

The land share elasticities represented by $\beta^{s}_{f,h}$ in equation 7 are interpreted as the percentage change in share of cultivated land ($SH_{h,f}$) by households for crop f as a result of a one per cent change in the producer price (PP_f) of crop f (wheat, maize, sorghum, other food and cash crops). These are guesstimates and range from -0.05 to 0.05.

Equation 7

$$\log SH_{h,f} = \alpha^{s}_{h,f} + \sum_{f} \beta^{s}_{f,h} \log(PP_f)$$

Table 4.18: Land share elasticities (ES) ($\beta^{s}_{f,h}$)

Crop	**Wheat**	**Maize**	**Sorghum**	**Cash crop**	**Other food**
Wheat	0.05	-0.01	-0.01	-0.01	-0.01
Maize	-0.05	0.05	-0.05	-0.05	-0.02
Sorghum	-0.05	-0.05	0.05	-0.01	-0.01
Cash crop	-0.05	-0.05	-0.01	0.05	-0.01
Other food	0	0	0	0	0.05

Source: Guesstimates based on Lundberg & Rich (2002)

The livestock supply elasticity (equation 11) is 0.3 and the non-food supply elasticity (equation 13) is 0.5. These parameters were also obtained from Simler (2005).

4.4. Data limitations

Secondary data used in this study was collected for different objectives from the ones in this study; hence there are some limitations in the data. Again the BOS database is not sufficiently available to the community and has a lot of gaps. However, BOS is the official body that is mandated to give statistical information in Lesotho. Another limitation in the data is that it is obtained from different sources which use different techniques in collecting it. Nevertheless, some databases such as FAOSTATS and ITC have BOS as their source limiting the inconsistency in the data.

Another limitation lies in the parameter data. There is not enough time series data to estimate parameters for Lesotho and therefore the option remaining was to use data from the literature. This also was a problem since most of the information about Lesotho is not documented. The available data from the literature used in this study is the aggregation of parameters for all crops in Lesotho while for instance the study requires elasticities for individual products. In some parameters guesstimates were made based on the data available in the literature. Some elasticity data is the data from Malawi, which is indicated by literature to be similar to Lesotho. This on its own is another limitation as no country is similar to another in terms of everything. Though countries may fall in the same category in terms of economic size and geographical features, consumption and production patterns are unique in each country. It is for these reasons that results in this study should be interpreted with caution.

The model adopted in this study was a generic model designed for Africa with a specific application in Madagascar. The Lesotho agricultural climate is divided into four agro-ecological zones, the lowlands, mountains, foothills and the Senqu river valley. These zones contain both urban and rural areas, except for Senqu river valley which is only rural. Because there are poor and rich households in those zones this model was supposed to have 14 households' groups but it only has four. The household groups were limited to four due to lack of sufficient data. Though agricultural production data is reported on those zones, other data such as consumption, prices and income are reported on districts basis. Aligning the district data with the zones was going to be difficult.

4.5. Model limitations

There are several factors that affect production other than fertiliser prices that this model does not incorporate. These among others include rainfall, drought, and labour. Rainfall and drought play an important role in agricultural production in Lesotho as it is mainly rain-fed. Production decisions are more influenced by climatic factors than fertiliser prices in Lesotho as fertiliser is only considered as a luxury. This is indicated by the elastic fertiliser own-price demand elasticity. Animal manure is a close substitute for fertiliser, however it is not included in this model as data on animal manure prices are not available. Also fertiliser prices form the major part in agricultural policy formulations in the model, but the impact of equally important issues such as floods and droughts are not taken into account.

Labour is a crucial factor in agricultural production. Labour was assumed to be household member in the original model because the authors surmised that it is best analysed in the computable general equilibrium models. However, in other studies that applied the same model labour is modelled explicitly. In this study, labour is also assumed to be household members employed for household production. Not explicitly modelling wages creates bias when calculating income. Nevertheless, it does not create such a notable bias in less developed countries as in developed countries because of the use of family labour. Production is mostly subsistence in less developed country, Lesotho being such a case.

Another limitation of this model is that it ignores the alternative uses of scarce government funds used in the fertiliser subsidy program to be compared to the opportunity cost of the scarce subsidy resources. In addition, the model does not incorporate the efficiency of the fertiliser subsidy program. These would be helpful in recommending alternative policies to the fertiliser subsidy. The current study quantifies only the household welfare effects brought by removing fertiliser subsidy program on agricultural production.

4.6. Summary and conclusion

This chapter presented the methodology used to achieve the objectives of this study. It is the model that was originally developed by Lundberg and Rich (2002) as a generic model for Africa with an application to Madagascar. The model structure did not change but the set components used for Lesotho are however different to the one used for Madagascar.

There are four household groups in this model. These include the poor households in both rural and urban areas as well as the rich households in urban and rural areas. They were determined by the use of the Continuous Multi-Purpose Survey data obtained from the BOS. Income served as a benchmark for classifying households into poor and rich. Availability of data hindered the classification of households used in this model to reflect Lesotho’s geographical aspects.

Products or commodities included in the model are maize, wheat, sorghum, cash crops, other food and non-food items as well as fertiliser. The level of data of each product has to be specified for each household group. Most of the data were sourced from the BOS and the MOAFS. The BOS is the official body mandated to provide statistical information in Lesotho. Other data were sourced from FAOSTATS, FAO GIEWS and ITC. Data on some elasticity used were obtained from various sources in the literature while other elasticity data were guesstimates. Additional information was obtained from Ministry of Trade and Industry, Cooperatives and Marketing.

The model does not incorporate other drivers of crop production such as climate variables. Also the model does not incorporate an alternative policy to determine the opportunity cost of retaining the fertiliser subsidies.

5. Results and discussions

5.1. Introduction

This chapter gives the model results of the household welfare effects of removing the government fertiliser subsidy program. This is achieved by analysing changes in prices, crop supply, consumption, trade, income and government revenue induced by the fertiliser subsidy removal. The next section (section 5.2) gives the results of the removal of the fertiliser subsidy. This section includes the analysis of the results, the welfare analysis and sensitivity analysis. Section 5.3 gives the comparison of the results with the literature. Lastly on this chapter (section 5.4) is the presentation of the summary and conclusion of the chapter.

5.2. Results analysis of subsidy removal

5.2.1. Commodity Prices

An increase in the price of fertiliser input raises output / producer prices (PP) of sorghum, other food and livestock. As shown in table 5.1, the consumer price (CP) of sorghum increases from M4.28/kg to M4.62/kg and the producer price increases from M3.72/kg to M4.02/kg. The producer price of other food increases from M2.86/kg to M3.34/kg while the consumer price rises from M3/kg to M3.51/kg. The consumer price of livestock increases from M55/kg to M68.03/kg and its producer price increases from M47.83/kg to M59.16/kg. Livestock, other food and sorghum are assumed to be internationally non-tradable products in the model, due to very low trade volumes; hence, their prices are determined by local demand and supply. The abbreviation WS in table 5.1 denotes the price without the subsidy.

The removal of fertiliser subsidies does not have an impact on both producer and consumer prices of maize, wheat, cash crops and non-food. This is because these products are linked to international markets because they are internationally tradable products; hence, their prices are not affected by changes in domestic markets. Though one of the goals of the subsidy was to lower staple food prices, local production of main staples (maize and wheat) is not sufficient to affect prices. Historic data on imports and production (see figure 3.3) indicates that the average annual imports of maize and wheat exceed production by about 100%. Domestic production meets about 30% of country consumption requirements and the remaining 70% is met by the imports specifically from South Africa (CBL, 2012a; Matsoai et al., 2010). However, local production levels of sorghum, livestock and other food are higher than their import levels and thus their prices are influenced by local production.

Lesotho does not produce fertiliser and its fertiliser consumption is insignificant in the world hence changes in domestic fertiliser prices cannot change international prices. Table 5.1 shows the prices when there is a 50% fertiliser subsidy and when it is removed. It can be noted that there are no changes in import prices (PM), export prices (PX) and world prices (PW) for all the products.

Prices in local currency unit are converted to international prices by using the 2012 average exchange rate available from the World Bank website. The base year was the period 2001 to 2005 and the value of average exchange rate used is 8.21. It was determined through the annual average based on monthly averages in local units (Maloti) relative to the US dollar (World Bank, 2015).

Table 5.1: Commodity prices (M/kg, $/kg) in 2012/2013 marketing year

Commodity	Consumer price (PC)		Producer price (PP)		Import price (PM)		Export price (PX)		World price (PW)	
	Base	**WS***	**Bas**	**WS**	**Bas**	**WS**	**Base**	**WS**	**Base**	**WS**
Wheat	5.70	5.70	4.96	4.96	4.39	4.39			0.36	0.36
Maize	4.36	4.36	3.79	3.79	3.35	3.35			0.27	0.27
Sorghum	4.28	4.62	3.72	4.02	3.87	3.29			0.28	0.28
Cash crop	27.00	27.00	23.48	23.48	20.77	20.77	30.52	30.52	5.58	5.58
Other food	3.00	3.51	2.86	3.34	2.31	2.31			0.19	0.19
Livestock	55.00	68.03	47.83	59.16	42.31	42.31			3.44	3.44
Non-food	100.0	100.0	90.9	90.9	76.9	76.9	108.3	108.3	21.59	21.59
Fertiliser	2.20	4.40	2.20	4.40	1.38	1.38			0.10	0.10

Source: Model simulations

*Without subsidy

5.2.2. Supply

The full removal of a subsidy results in a 57.26% reduction in demand for fertiliser (table 5.4). This causes the fall in crop yields as well (see table 5.2). The effect is more on poor households than their rich counterparts. This is because poor households do not have the capacity to substitute or shift their resources; hence, they are more vulnerable to price changes. Yields of rich households in urban areas for maize decline from 0.81 tons/ha to 0.71 tons/ha and those of poor households decline from 0.80 tons/ha to 0.65 tons/ha. Maize yields of rich households in rural areas decline from 0.89 tons/ha to 0.78 ton/ha, while maize yields of poor rural households fall from 0.83 tons/ha to 0.66 tons/ha. Cash crops’ yields for rich households in rural areas are however not affected by the fertiliser price reform.

Table 5.2: Household crop yields (HYLD) (tons/ha) in Lesotho in 2012/2013

Household	Wheat		Maize		Sorghum		Cash crop		Other food	
	Base	WS*	Base	WS	Base	WS	Base	WS	Base	WS
Urban rich	1.29	1.20	0.81	0.71	0.90	0.83	0.31	0.29	0.78	0.73
Urban poor	1.24	1.12	0.80	0.65	0.85	0.77	0.30	0.23	0.55	0.51
Rural rich	1.31	1.22	0.89	0.78	0.97	0.89	0.28	0.28	0.82	0.77
Rural poor	1.25	1.13	0.82	0.66	0.84	0.76	0.29	0.26	0.60	0.56

Source: Model simulations

*Without subsidy

A general fall in crop yields with area cultivated remaining the same prompts a decline in crop production. Table 5.3 indicates that maize production is affected most with a reduction of about 15% followed by wheat with about 8% reduction. Application of fertiliser is mostly concentrated on maize production. Therefore, an increase in fertiliser prices causes the marginal cost of maize production to be higher than that of other crops, thus the huge drop. Sorghum and cash crop supply declined by about 7% while other foods showed a modest reduction of about 3%. Sorghum and other foods production declined despite their increased producer prices (PP). This implies that producers respond more to production costs than output prices. According to Mokitimi (1995) an increase in producer and consumer prices is expected to result in reduced production for deficit producers as the little income is spent to meet household consumption needs. One would expect sorghum production for rich households in this study to increase. This shows that households' application of fertiliser is heavily dependent on the fertiliser subsidy.

A rise in the producer price (PP) of livestock results in about 6.6% increase in livestock supply. This might be another reason for a decline in crop production as farmers might have shifted resources away from costly crop production to livestock production. Maize is the main input in livestock production, since the consumer price (PC) for maize is not affected by the reform it is justifiable to presume that increased production of livestock shifted resources from crop production to livestock production. Lundberg (2005) supported this argument, he stated that some households are likely to shift production from fertiliser intensive produce to produce that use less fertiliser. This is likely the case for urban households where livestock (poultry) production is mostly practiced. Non-food supply is not affected by the reform.

The decline of crop supply as a result of an increased price of fertiliser supports several government and stakeholders reports that indicate that agricultural production in Lesotho is low due to limited use of inputs, among other reasons.

Table 5.3: Commodity supplied (SCR, SLV, SNF) (tons) to Lesotho in 2012/2013

Commodity	Base	Without subsidy	Change (%)
Wheat	12,774	11,733	-8.15
Maize	86,325	73,148	-15.26
Sorghum	20,405	18,893	-7.41
Cash crops	3,357	3,114	-7.24
Other food	3,582	3,458	-3.44
Livestock	3,581	3,817	6.59
Non-food	4,070	4,070	0

Source: Model simulations

As indicated in table 5.4, a reduction in fertiliser subsidy by 10% lowers the demand for fertiliser by 14.6%. A 30% reduction in fertiliser subsidy reduces fertiliser demand by 24% while a full removal of the subsidy results in a 57% decline in fertiliser consumption. This shows that the fertiliser price is crucial in determining the demand for fertiliser.

Table 5.4: Fertiliser demand (DFERT) (tons) in Lesotho in 2012/2013

Subsidy rate	Fertiliser demand (tons)	% change
Base	7,818.66	
10% subsidy reduction	6,675.55	-14.62
20% subsidy reduction	5,913.18	-24.37
30% subsidy reduction	5,047.28	-35.45
40% subsidy reduction	4,174.96	-46.60
50% subsidy reduction	3,341.63	-57.26

Source: Model simulations

5.2.3. Income

Incomes for rural household groups decrease owing to the decline in households crop supply. Agricultural income of rich households declined by 2.6% and for poor households it declined by 4.8%. This is because crop production is more concentrated in rural areas and a major decline in crop supply impacts more on rural households. An increase in livestock production has resulted in a rise in urban households' agricultural income. Rich urban households gained more with agricultural income increasing by 7% and the gain in agricultural income of urban poor households increased by 0.41%. A fall in agricultural income of rural households consequently resulted in a decline of their total income. Total income of rich households in rural areas declined from M392,750 to M391,330 and that of poor households dropped from M234,940 to M229,070. Similar to agricultural income, total income in urban households increased with rich households gaining more.

Table 5.5: Household incomes (M1000) in Lesotho in 2012/2013

Households	Agricultural income (YHAG)			Income (YH)		
	Base	WS	% change	Base	WS	% change
Urban rich	163.38	175.09	7.17	262	276.76	5.82
Urban poor	125.08	125.60	0.41	160	161.40	1.1
Rural rich	250.69	244.18	-2.6	393	391.33	-0.36
Rural poor	170.54	162.35	-4.8	235	229.07	-2.5

Source: Model simulations

5.2.4. Consumption

An increase in consumer prices (PC) of sorghum, other foods and livestock results in a reduction in their consumption (CONS) for all household groups. Sorghum consumption declined by 7%, other foods by 11% and livestock consumption decreased by 25% (table 5.6). Alternatively, consumption of wheat increased by 8%, maize 3% and consumption of cash crops and non-food increased by 28% and 1% respectively. An increase in consumption of these commodities is attributed to their unchanging consumer prices.

Table 5.6: Consumption (CONS) (ton) in Lesotho in 2012/2013

Commodity	Base	Without subsidy	Change (%)
Wheat	106,129	114,701	8.08
Maize	242,754	249,818	2.91
Sorghum	20,404	18,892	-7.41
Cash crops	4,896	6,283	28.31
Other food	4,898	4,342	-11.34
Livestock	5,853	4,414	-24.59
Non-food	2,000	2,030	1.48

Source: Model simulations

Table 5.7 shows changes in consumption levels at households. It indicates that non-food consumption increases only in urban households with rich households consuming more. This is because as income increases, spending on non-food products increases. The increase in non-food consumption is by urban households. This is because of the increased income of urban households. Similar to total consumption, household consumption increases in products whose consumer prices remained unchanged when the subsidy is removed and dropped in products that became more expensive (sorghum, other foods and livestock).

Table 5.7: Percentage change in household consumption (HC) in Lesotho in 2012/2013

Household	Wheat	Maize	Sorghum	Cash crops	Other food	Livestock	Non-food
Urban rich	9.70	5.24	-5.45	31.69	-9.11	-22.73	73.59
Urban poor	8.08	3.15	-7.29	28.57	-11.26	-24.89	3.81
Rural rich	7.55	2.54	-7.77	27.57	-11.95	-25.56	-10.50
Rural poor	6.53	1.38	-8.78	25.36	-13.48	-26.43	-20.18

Source: Model simulations

Consumption in terms of calorie intake increases for all the household groups with urban households gaining more. Total calorie intake for urban rich increases from 9,237 kcal to 9,803 kcal and for the rural poor it increased from2, 098 kcal to 2,148 (table 5.8). The reason for general increases in calories for all household groups despite the decline in consumption of other commodities is that the increased commodities constitute a greater bulk of calorie intake. Similar to commodity consumption shown in table 5.6, the average calorie consumption of commodities increased in products whose prices were not affected by the reform (table 5.9).

Table 5.8: Household calorie intake (TOTCAL) (kcal) in Lesotho in 2012/2013

Household	Base	without subsidy	% change
Urban rich	9,237	9,803	6.13
Urban poor	5,346	5,572	4.23
Rural rich	10,893	11,225	3.05
Rural poor	2,098	2,148	2.42

Source: Model simulations

Table 5.9: Average calories consumed by one person per day (CALAVG) (kcal) in Lesotho in 2012/2013

commodity calorie cons	Base	without subsidy	% change
Wheat	1,649	1,782	8.08
Maize	2,600	2,675	2.91
Sorghum	218	202	-7.41
Cash crops	49	63	28.31
Livestock	102	77	-24.59
Other food	9	8	-11.34

Source: Model simulations

5.2.5. Trade

A fall in crop production implies an increase in imports. As mentioned in previous chapters, Lesotho is generally a net importer of food products. XMGR in table 5.10 represents the change in net imports. As can be expected the increase in net imports is on products whose consumption has increased. Other food and livestock trade decline due to their reduced demand by households. The base in fertiliser trade is the amount of fertiliser imported by individuals and private traders. Therefore, the increase in fertiliser imports without the subsidy is the increase in private imports. Though the demand for fertiliser declined (table 5.4) when fertiliser prices increases, the private sector in fertiliser markets has improved.

Table 5.10: [2]Trade (tons) in Lesotho in 2012/2013

Commodity	Base	without subsidy	XMGR %
Wheat	93,355	102,968	10.30
Maize	156,434	176,675	12.94
Sorghum	0	0	0
Cash crops	1,539	3,168	105.86

[2] The model assumptions do not allow domestic prices of products included as set elements of tradable products to change, but if small base values of trade are included in the model then the model does allow for changes in imports and exports.

Commodity	Base	without subsidy	XMGR %
Other food	1,316	884	-73.73
Livestock	2,272	597	-32.83
Non-food	-2,070	-2,041	-1.43
Fertiliser	2,622	3,342	27.46
Government fertiliser	5197	0	0

Source: Model simulations

5.2.6. Program costs

Table 5.11 shows the cost of the fertiliser subsidy program. At 10% subsidy the program costs the government M7.14m and at 20% subsidy, the cost of the program is M8.1m. The current rate of subsidy (50%) amount to M10.11m. Provision of a 50% subsidy creates an opportunity cost of M10.11m. A simple analysis of historic levels of staple foods supply shows that grain imports play a greater role in ensuring food availability in the country than local production. In most instances, climatic factors were held accountable for low levels of production. While that cannot be blamed on anyone as natural disasters are beyond the control of the farmer, taxpayers' money is used to cover the costs of the failed production. Moreover, food subsidies are often needed to help households recover after poor harvests implying more costs to tax payers. For these reasons, fertiliser subsidies are not the best policy to improve welfare in Lesotho. The alternative, though not captured by the model could be to fund the non-farm income generating activity programs with the M10.11m to help poor households afford the imported food products.

Table 5.11: Program costs (million Maloti) in Lesotho in 2012/2013

Subsidy rate	Gov. costs (million Maloti)
10% subsidy	7.139
20% subsidy	8.131
30% subsidy	8.923
40% subsidy	9.568
50% subsidy	10.11

Source: Model simulations

5.2.7. Welfare analysis

The approach followed in this study to determine welfare is the one used by Siam and Croppenstedt (2007) in their multi-market model approach to analyse the liberalisation of the Egyptian's wheat markets. They used the changes in household calorie and per capita income changes as well as the changes in household consumption. Other indicators of welfare such as price and government revenue will also be used in the analysis.

In terms of income as an indicator of welfare, urban households on the one hand are better off as their incomes have improved. On the other hand, the welfare of the rural households is worse off because their income deteriorated. Rich households in urban areas gained more in this reform while poor households in rural areas are the most adversely affected. Nationally the country is worse off in terms of income as a measure of welfare because the majority of the population (rural households) are affected negatively.

Using consumption as an indicator of welfare, make all households better off as household consumption of the main staple foods, maize and wheat, has increased. Similarly, in terms of caloric intake the welfare of all households has improved with the rich households in urban areas increasing more. This is also because the bulk of the calories taken in households are made up of products whose consumption has increased.

Removing fertiliser subsidies therefore does not make the country worse off in general. The money saved for removing the project could be used to fund projects that could uplift the poor in rural areas. These could be non-farm activities or livestock production as the results in this study indicated these to have contributed to the increased income of urban households. Also broiler production is not affected by climate variables like crop production.

5.2.8. Sensitivity analysis

In a multi-market model, the supply and demand results can vary significantly due to changes in the parameters used in the equilibrium model equations. Therefore, sensitivity analysis was done to determine the impact of crop with fertiliser price elasticities on consumption, crop supply and household income when elasticity is varied. In order to determine how sensitive the results are to the elasticity used, the values of crop fertiliser price elasticities in the model are halved and doubled. This is because the change in the fertiliser price is the simulation scenario in the model. Consumption results when the parameters are halved differ hugely from when the original parameters are used, except for maize, livestock and non-food consumption results (figure 5.1). When the elasticities are doubled consumption results of other food and cash crops align moderately with the original results.

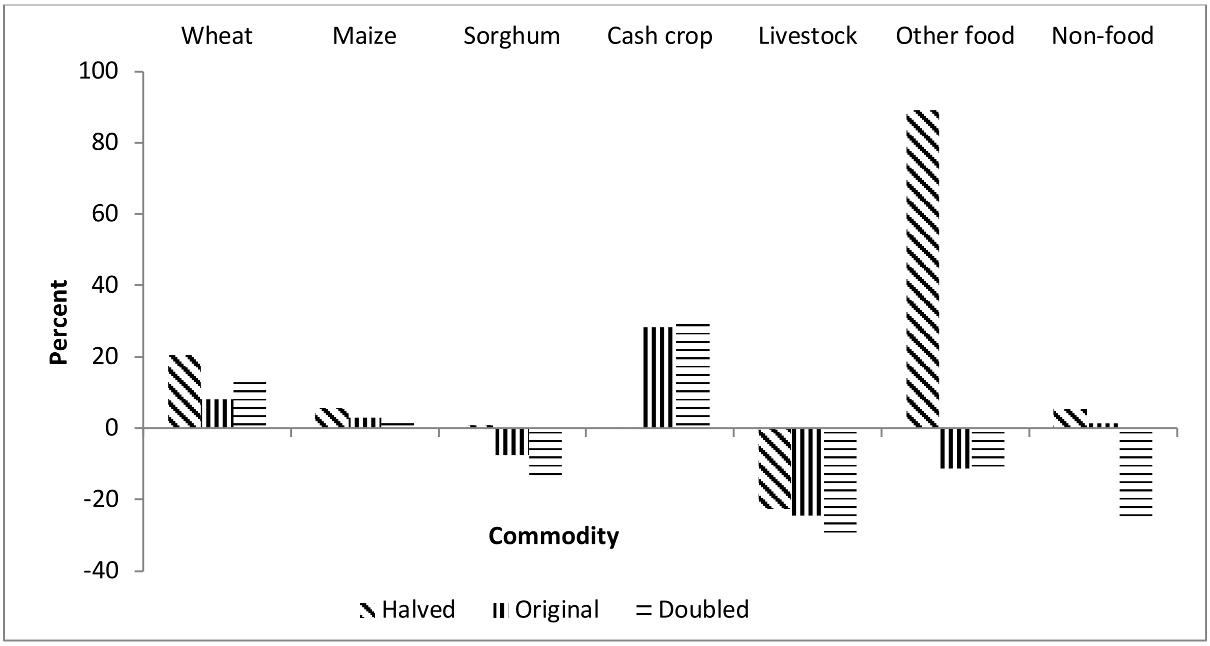

Figure 5.1: Impact of varying crop fertiliser price elasticities on consumption of commodities percentage changes in Lesotho in 2012/2013

Source: Model simulations

Figure 5.2, shows the impact of varying elasticities on crop supply percentage changes. For the supply of crops doubling the elasticities doubles the results and halving elasticities halves them. The only difference is on supply of other food whereby the supply response when elasticities are halved is close to the response from original values but differs hugely when elasticities are doubled. Livestock supply respond in a different direction from the original response when elasticities are halved and doubled.

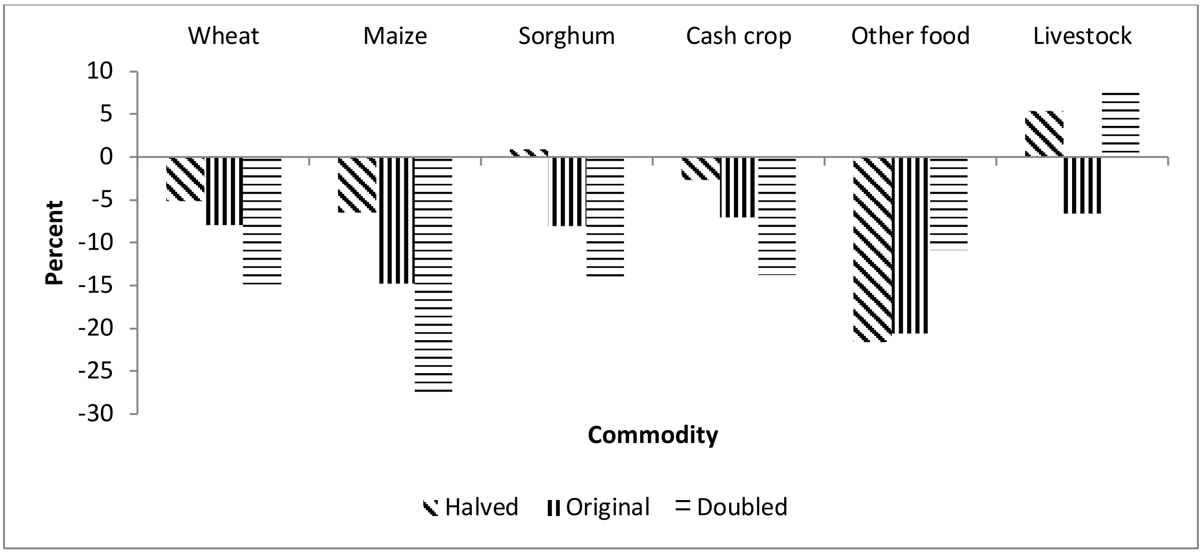

Figure 5.2: Impact of varying crop fertiliser price elasticity on crop supply percentage changes in Lesotho in 2012/2013

Source: Model simulations

With regards to income, figure 5.3 indicates that urban rich households' income response to elasticities is moderately aligned to the original elasticities response when parameters are halved and doubled. For other household groups the results when parameters are halved and doubled vary hugely from the original results. This implies that one has to be cautious in selecting the elasticities as there can be bias in predicting the results.

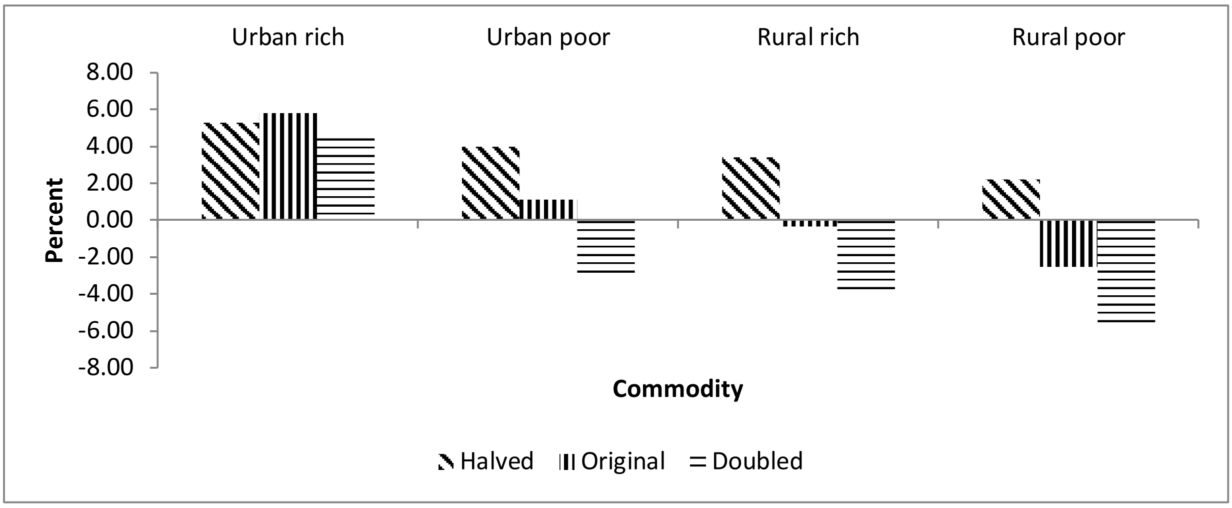

Figure 5.3: Impact of varying elasticity on household income percentage changes in Lesotho in 2012/2013

Source: Model simulations

It can be concluded that the results from the models are highly sensitive to changes in elasticity. These results also imply that the researcher should be cautious when selecting elasticity to be used. This will be particularly important where there is neither elasticities from the literature nor those that are econometrically estimated.

5.3. Results comparison with the literature

The unchanged prices of maize and wheat drawn from the results in this study correspond to the findings of Takeshima and Liverpool-Tasie (2013) on their analysis of the influence of fertiliser subsidy on food prices in Nigeria. They used district panel data to explore the link between a fertiliser subsidy and maize, sorghum and rice prices in Nigeria. Their findings indicate that in general a fertiliser subsidy does not have an impact on prices of grains under investigation except for the prices of rice in northern Nigeria. This is because the majority of farmers in North Nigeria produced rice for commercial purposes but beneficiaries of the subsidies in other parts of the country were subsistence farmers. Similarly, about 80% of the farmers in Lesotho produce for subsistence purposes (BOS, 2012c).

Lesotho is in close proximity to South Africa such that some individuals buy groceries in South Africa. However, it cannot be ignored that in some remote areas of the country, production may have an effect on prices in harvest season. It is a limitation of the model in this study to not incorporate seasonality changes in prices like Stifel and Randrianarisoa (2006) did in their Madagascar model.

Dorward and Chirwa (2013) (cited in section 2.6.1.1) found that the subsidy program contributed to increased maize production, farm income and low maize prices in Malawi. This was supported by Ricker-Gilbert, Mason, Darko and Tembo (2013) in their analysis of the effects of an input subsidy program on maize prices in Malawi and Zambia. Malawi is a net consumer of maize and since it became a net exporter of maize after the introduction of the program, it is justifiable that maize production affects maize prices in local markets. The case is not applicable to Lesotho, because as mentioned previously, imported maize and maize products still dominate local markets.

The effects of increased sorghum and livestock prices similar to the one in this study are supported in Mokitimi (1995). He explained that for deficit producers, an increase in producer prices results in low production, but for surplus producers it resulted in high production. Grain farmers in Lesotho are mostly subsistence while livestock (broiler) farmers produce mainly for markets. Nevertheless, crop production in this study is a function of producer prices and consumer price of inputs.

Input subsidies are accused of crowding out the private sector in most studies about subsidies in sub-Saharan Africa (Mason, Jayne & Mofya-Makuka, 2013; Jayne & Rashid, 2013; WB, 2013). One of the objectives in this study was to determine the impact of removing fertiliser subsidy on fertiliser demand. The results indicate that demand for fertiliser declines by more than half. However, imports of fertiliser increases by about 25%. This shows that the fertiliser subsidy in Lesotho has negative effects on commercial markets for fertiliser as well.

5.4. Summary and conclusion

In this chapter the effects of removing the fertiliser subsidy in Lesotho are analysed. The impact of removing the 50% fertiliser subsidy on production, prices, income and consumption was modelled in a multi-market model. The study looked at the impact of elimination of this subsidy on fertiliser demand, calorie intake, as well as trade. The elimination of the fertiliser subsidy does not have impact on consumer and producer prices of maize, wheat, cash crops and non-food. This is because these products are internationally tradable and because Lesotho is a small country in an open economy, so prices of these products are linked to international markets. The fertiliser subsidy price reform increases the prices of sorghum, other foods and livestock. This is mainly because prices of these products are determined by supply and demand in local markets.

The reform causes production of wheat and maize to decline with the production of maize being affected most. This is because fertiliser use is higher in maize production than for other crops. In contrast to crops, production of livestock increases due to the rise in its producer price. However the rise in producer prices of sorghum and other foods does not lead to increased production. This shows that crop production is influenced more by fertiliser prices. Production of non-food is not affected by the fertiliser price increase.

An increase in livestock production increases both agricultural income and total income of urban households. Incomes in rural households decline as crop production declines. This is explained by the fact that crop production is dominant in rural areas while livestock production is an urban activity. Rural households have the largest share of land; hence their incomes are influenced by land intensive activity (crop production).

Household consumption for all products except sorghum, other foods and livestock, increases. Consumption of non-food increases only in urban households. The increased income in those household groups explains the rise in non-food consumption. Consumption of maize and wheat increased because of their low market prices. Calorie intake increased in all household groups. This is because consumption of the increased products (maize and wheat) constitutes a big share in household consumption.

The reduced supply of wheat and maize is enhanced by imports to meet the country’s consumption needs. Net imports of all the products increased except the one for livestock and other food. For livestock, this is because of the rise in supply while for other food it is explained by the huge drop in demand. Elimination of government imports on fertiliser resulted in decreased consumption of fertiliser. However, private imports on fertiliser improved. The subsidy program had cost the government M10.11million. This amount excludes administrative costs involved. In eliminating the program, this amount is gained.

Sensitivity analysis was done to gauge how sensitive consumption, production and income percentage changes results are to the parameters used. This was done by halving and doubling the crop with fertiliser elasticities. The results in this study are sensitive to elasticities hence need to be interpreted with caution as elasticities data are obtained from the literature and some are guestimates. Using parameter data from the literature is the only option in cases where data is not available to calculate elasticities.

In analysing welfare using, income, consumption and calorie intake concepts, it can be deduced that the general welfare of urban households has improved. For rural households, welfare only improved in terms of consumption and calorie intake. In looking at income alone, the welfare has declined because rural households constitute the great part of the population. The rural poor are the most affected by the reform. The M10.11m could be used to help boost their income. This could be by inception of activities that generate non-agricultural income.

Much of the literature on the role of fertiliser subsidies in enhancing production, income and food prices questions its ability to do that. The fertiliser subsidy does improve crop production which improves agricultural income. Production in most sub-Saharan countries is not sufficient to affect grain prices, but where it does, the magnitude is small compared to the cost of fertiliser subsidy programs.

6. Summary, conclusions and recommendations

The use of a fertiliser subsidy to enhance food security and alleviate poverty through increased production has gained popularity in many sub-Saharan countries. This is despite the discouragement of subsidies by the development institutions and economists. The main argument against input subsidies is that they result in inefficiencies in resource allocation and put huge financial strain to these poor countries.

Lesotho is no different to these other countries in Africa south of the Sahara. Agricultural support started in 1980/81 agricultural year with the aim of attaining self-sufficiency in main grain staple foods. These are maize, wheat and sorghum. During the mid-1990s the government involvement in agricultural markets ceased. This was after the realisation that subsidies distort markets and that they create a culture of dependency among the farmers. Also the government realised that production was still at the same levels prior to subsidy program.

Between the period 1980/81 and 1996/97 when subsidies were eliminated, production has been fluctuating with some years being high while in most years it was low. For example, production levels in 1987/88 to 1988/89 increased from early 1980s levels and decreased abruptly from 1990/91 to 1994/95. It increased again in 1995/96 and remained stagnant from 1997/98 to 1998/99 (figure 3.6). The low levels of production in 2001/02 led to the re-emergence of the input subsidies in 2002/03. The agricultural subsidy policy note indicates that input subsidies will only be used as remedy after natural disasters. A targeted subsidy ran from 2002/03 to 2008/09, however production levels remained low over that period (see figure 3.6). Low levels of production were attributed to drought and floods. The rise in production in 2009/10 is attributed to block farming, a government initiative scheme to support commercial farming.

In 2009/10, the Government of Lesotho continued with the input subsidy program with the aim of ensuring household food security. The subsidy was however no longer targeted. This was a response for continuing declining agricultural production and escalating food prices. The duration of the program is not clear. Crop production, specifically maize had still been fluctuating with low levels in most of the years. Grain imports are increasing to flood local markets.

The question this study is addressing is the extent to which a fertiliser subsidy impacts on crop production in Lesotho. Increased production as a result of a subsidy is expected to reduce domestic food prices and increase household farm income; thus, ensure household food security and improves household welfare. To address the research question, the study employs a multi-market model developed by Lundberg and Rich (2002) to determine the impact of removing the fertiliser subsidy on production, prices, income and consumption. The model also incorporates the effect of eliminating the fertiliser subsidy on fertiliser demand, trade and calorie intake.

The multi-market model is a partial equilibrium model that is solved using a non-linear programming (NLP) solver option of GAMS software. The product side of the model includes maize, wheat, sorghum, cash crops, other food, livestock and non-food while the input side consists of fertiliser. Household groups are classified into rural poor, rural rich, urban poor and urban rich.

The core of the model is the set of equations describing the demand and the supply sides of the model as well as the market clearing conditions. The demand side is composed of a matrix of own and cross price elasticities of commodities used in the model and a vector of income elasticities for such commodities. The parameters measure the behaviour of the consumers as commodity prices or household income change due to a change in policy of which in this case is a fertiliser subsidy.

The supply side consists of detailed information of product supply and input demand elasticities to estimate product supply and input demand systems. These reflect profit maximisation behaviour. The parameters are differentiated across all the household groups to determine total yield and commodity supplies, fertiliser demand, and net revenues. It is assumed that fertiliser supply is exogenous and land is fixed. The land allocation to the crop is determined by equating the marginal revenue product for each use. The equilibrium conditions of the model are then set for each commodity used in the model. For non-tradable goods, this is done by equating demand to supply at all market levels. For tradable commodities demand and supply equilibrium conditions are determined by the border price and net exports.

The findings point out that the fertiliser subsidy has an impact on crop production. This was shown by the reduction in production as subsidy is removed. The 15% decline in maize production implies that 15% of the maize production in 2012/2013 agricultural year was a result of fertiliser subsidy. Fertiliser subsidy contributed to about 8% and 3% increase in wheat and other foods production respectively. About 7% of sorghum and cash crops production were a result of fertiliser subsidy. The study also looked at the effects of the fertiliser subsidy on products that do not use fertiliser as their input directly but are related indirectly to fertiliser markets. The results indicate that production of livestock increases by 6.6% as fertiliser subsidy is removed while non-food production remains the same.

One of the objectives of the fertiliser subsidy is to increase household income, ironically, incomes of urban households increase when the subsidy is removed. As one would expect incomes of rural households decrease. Poor households in rural areas depend more on the fertiliser subsidy for income generation as they are the most adversely affected. This shows that if fertiliser subsidy is to be continued, it should be targeted to poor households in rural areas otherwise it should be eliminated. Increased income in urban households is a result of increased livestock production.

Though the model in this study does not capture the effect of rainfall on crop production, it is evident from the literature discussed in chapter three that it is responsible for dwindling agricultural production. Since little can be done to control the effects of rainfall, much of the production budget should be allocated to livestock (broiler) production as it is not affected to the same extent by climate variables.

Prices that are affected by the reform are for products which the bulk of their consumption is made up of local production. These are sorghum, other foods and livestock. Prices of wheat, maize, cash crops and non-food were not affected because the prices of these products are determined by the import and export prices. Consequently, consumption of these products increased while consumption of sorghum, other foods and livestock decreases. Considering that maize and wheat are the most consumed and maize is the staple food, an increase in its consumption indicates improvement in welfare. Also, calories intake for all households increases.

As can be expected for a poor country like Lesotho where the majority of the farmers produce for subsistence purpose and are poor, demand for fertiliser dropped by 57%. This could perhaps be reversed by introducing non-farm income generating activities with the M10.11m gained when subsidy is removed, to help the poor households afford the purchased food.

Generally, the findings in this study reveal that removing the fertiliser subsidy in Lesotho does not make the country worse off when using consumption, calorie intake and prices as indicators of welfare. However, the fertiliser subsidy removal has adverse effects on the income of the poor people in rural areas. These findings suggest that the government of Lesotho may ensure sustainable food security and improve welfare by introducing non-farm income generating activities for the poor households. This will simultaneously enable them to afford their own fertiliser and imported food even when there are poor harvests due to floods and droughts. In addition, this will enable government to avoid the expensive administrative costs of fertiliser subsidies.

The following are recommendations drawn from the study.

Fertiliser subsidies use scarce public resources; hence, their impacts need constant evaluation. This could only be possible if data is available. It is therefore recommended for the Bureau of Statistics to include use of subsidised inputs on their questionnaire. Furthermore, it is recommended for the Ministry of Agriculture and Food Security to keep records of the amount of fertiliser and other subsidised inputs they distribute.

The model used in this study was adapted from the one that was used for Madagascar. In order to make it applicable for Lesotho's situation, set elements and parameters values were changed while the basic multi-market equilibrium equations were left unchanged. For further improvement on the model, the model can be further developed to focus on Lesotho demographics and economies. In addition, household groupings could be classified in such a way that climatic zones are incorporated as well as the effects of rainfall.

It is also recommended that the government of Lesotho should target the fertiliser subsidy to poor households in rural areas if they are to continue with the fertiliser subsidy policy. It is evident from the results that the fertiliser subsidy improves welfare of rural poor households. However, it is recommended that fertiliser subsidy be eliminated and the poor be helped with non-farm income generating activities such as cash for work programs. In this way they can buy their own fertiliser and be able to afford the imported food in the market.

Lastly, it is recommended that future studies extending on this work should add more scenarios to include alternative use of government revenue gained when subsidies are removed to determine the opportunity costs. It will also allow further sensitivity analysis to be done on the parameters in order to have the full spectrum of parameters having an impact on commodities.

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